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EVALUATION OF POTENTIAL INSPECTION/MAINTENANCE BENEFITS ON VEHICLES OPERATED AT HIGH ALTITUDE

U.S. ENVIRONMENTAL PROTECTION AGENCY
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Office of Mobile Source Air Pollution Control
Emission Control Technology Division
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Recently, the EPA published in the Federal Register two significant supporting documents for I/M. The first document was a Notice of Proposed Rulemaking on the 207(b) Clean Air Act Warranty. The second document was a Notice of Proposed Rulemaking on Appendix N to the State Implementation Plan Guidance Document. Appendix N presents I/M credits for various types of I/M programs. Although both of these documents are expected to apply equally to high and low altitude regions, the majority of the data used to develop these documents have been collected at low altitude.

This report presents a thorough analysis of data collected at high altitude. The data were not collected in a real life I/M program; they are laboratory data. As such, they can be compared with laboratory data

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This report presents a thorough analysis of data collected at high altitude. The data were not collected in a real life I/M program; they are laboratory data. As such, they can be compared with laboratory data taken at low altitude and, in some subject areas, they can extend the general understanding of the costs and effectiveness of maintenance programs at both high and low altitude. The prime analysis objectives of this study were threefold: to estimate the effectiveness of I/M, to evaluate the correlation between the Federal Test Procedure (FTP) and various short inspection tests, and to examine any relationships which exist between emissions, engine condition, and vehicle usage.

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SECTION 1

INTRODUCTION

There are two principal methods of reducing the motor vehicle contribution to a regional emission inventory or emission hot spot. One method is to reduce the pollutants which are emitted from each vehicle on a per mile traveled basis, while the second method is to reduce the total number of miles traveled by motor vehicles, either nationally, regionally, or in a specific problem location. Although emission standards and compliance strategies associated with the manufacture of vehicles with properly operating emission control systems have normally been effected on a national level, transportation control strategies have been implemented on a state or local basis. National strategies include new car certification, assembly line testing, and recall of properly maintained vehicles which are substantially above emission standards. Regional strategies include inspection/maintenance (I/M), parking controls, vehicle miles traveled reduction strategies, improvements/incentives for public transportation, mandatory maintenance, roadside emission checks, etc. In this way, regions with more severe air quality problems can implement more comprehensive control strategies.

The effectiveness of I/M as a regional control strategy is based upon two key factors. First, vehicle emissions deteriorate with age. This deterioration is due partly to a gradual wearing of engine components and partly to lack of proper maintenance. I/M can reduce overall deterioration by ensuring that vehicles are properly maintained. Secondly, I/M is based upon being able to properly identify vehicles which can benefit from emission related repair. This identification can be based upon short emission tests, short diagnostic tests, or a general requirement for mandatory emission related maintenance. However, since I/M affects a large population in a given region, its implementation must be reasonable in both cost and time commitments from the public.

I/M programs have been the subject of several studies but most of the EPA effort, to date, has centered on low altitude regions of the country. Until 1977, vehicles sold at high altitude were built to be similar to those sold at low altitude. However, vehicle engine operation at high altitude differs from that at low altitude in that, at the same parametric settings, vehicles run rich at high altitude. The rich operation results in increased hydrocarbon (HC) and carbon monoxide (CO) emissions. This difference in vehicle operation at high altitude could result in different I/M benefits than those projected at low altitude.

Previous studies at low altitude have included the collection of FTP and short test data as well as the assessment of vehicle repair effectiveness. These data have been formulated into a simulation model which projects I/M benefits over the life of a vehicle. In addition, cost of repair information has been acquired. Several operational I/M programs exist at low altitude and these programs have been able to characterize the real world costs and short test measured benefits of I/M. At present, a major EPA test program is being performed to assess the real world effectiveness of an operational I/M program at low altitude. Since a real world I/M program does not exist in a high altitude location, this study attempted to address those aspects of I/M that could be measured in a laboratory environment. Three major question areas were examined: the effectiveness of I/M, the correlation between FTP and various short inspection tests, and the relationships which exist between emissions, engine condition, and vehicle usage. The information obtained from these analyses will be used by the EPA to develop a high altitude version of the I/M simulation model. That work will be published in a separate EPA report.

The data were collected in two phases on a random sample of in-use vehicles from the population of 1972 through 1976 model year vehicles. In Phase I, 193 vehicles were subjected to the Federal Test Procedure (FTP) and a series of short tests. Every vehicle then received an emission oriented tune-up, factory recommended maintenance if due, and the restoration of maladjustments and disablements. All emissions tests were then repeated. The Phase I data were then used to establish a pass-fail criteria on the basis of the idle in neutral (Idle (N)) short test which was designed to fail 35-40 percent of the vehicles in each of two model year groupings: 1972-1974 model years and 1975-1976 model years. An additional random sample of 470 vehicles from the population of the same model year vehicles was then obtained and this sample was designated as Phase II. Each of the vehicles in Phase II was given the Idle (N) short test and those which passed the idle test were not tested further. Those vehicles which failed were then given the same set of tests and maintenance actions as was given to the Phase I vehicles. The two phases provided a sample of 382 vehicles which were subjected to FTP and short test emission evaluations before and after maintenance actions. For all of these vehicles, complete records were maintained on the type and costs of maintenance actions, the condition of the vehicle as received, and other pertinent data. A complete description of the vehicle selection and testing procedure can be found in Reference 1 and a summary is provided in Paragraph 3.1 of this report.

Section 2 of this report will present a summary of the major conclusions of the study, while Section 3 will contain a technical discussion of methodology and results. Both sections will be divided into the three major study areas. Within each study area, a series of problem statements have been formulated. The presentation of results by study area and specific problem areas has been used in order to effectively present the large amount of data analysis which has been performed.

SECTION 2
SUMMARY OF RESULTS

A summary of the major results in each of the three primary interest areas is presented in this section. The data and analyses supporting these conclusions are presented in Section 3.

2.1 EXPECTED BENEFITS OF HIGH ALTITUDE I/M

1. Estimation of Idle (N) I/M Program Effectiveness

Table 2.1 presents estimates of the average first year effectiveness for different stringency factors in an I/M program based on the Idle (N) short test. At high altitudes, the NOX emissions and fuel economy are unaffected by I/M while significant reductions in HC and CO emissions are possible. To compare the potential I/M pollutant reductions of this program with those of previous high altitude programs and the Appendix N estimates, Table 2.2 presents the estimated benefits for a 40 percent stringency factor. The 1975-1976 model year percentage reductions obtained from this study are in close agreement with those of the Reference 3 Colorado report. The CO reductions of this report are within the range of those of Appendix N for both model year groupings. The HC reductions are within the range of those of Appendix N for 1972-1974 model years, but are greater than those of Appendix N for the 1975-1976 model years.

With respect to the benefits to be gained and the comparison with the Appendix benefits, it should be noted that the maintenance actions in Denver were performed by trained contractor mechanics. However, the emissions oriented tune-up performed on the vehicles in this program returned the vehicle to a manufacturer recommended condition for low altitude regions which is not optimum for high altitude operation. Therefore, the maximum possible emission reductions are not achieved during the maintenance actions. The net effect of this factor on any comparisons is unknown.

TABLE 2.1

PERCENT BENEFIT FROM I/M PROGRAMS BASED ON THE IDLE (N) SHORT TEST

Model Years	Stringency Factor	HC	CO	NOX	F.E.
1972-1974	10	6	3	1	0
	20	8	8	0	0
	30	10	12	0	-1
	40	12	15	1	-1
	50	14	18	1	-1
1975-1976	10	8	10	1	0
	20	14	16	2	0
	30	19	20	4	0
	40	23	25	5	0
	50	28	27	7	0

TABLE 2.2

ESTIMATED PERCENT BENEFIT FROM I/M PROGRAM WITH 40 PERCENT STRINGENCY FACTOR

	HC	CO	NOX	Fuel Economy
12/73 Colorado Report (Ref. 2)				
1964-1967 Models	4.4	2.4	2.3	-0.8
1968-1973 Models	18.0	10.8	1.1	1.4
3/76 Colorado Report (Ref. 3)				
1975 Models	24.6	24.3	4.7	1.0
Appendix N* (Ref. 4)				
1972-1974 Models	8-13	14-22		
1975 Models	12-15	23-32		
Current Report				
1972-1974 Models	11.7	15.1	0.9	-1.0
1975-1976 Models	23.4	25.0	4.8	0.1

* First year benefit without mechanic training.

2. Comparison of After Maintenance Emissions with Passed Vehicle Emissions

Average Idle (N) emissions of repaired vehicles were below the cutpoints for each stringency factor but the repaired vehicle Idle (N) averages tend to be greater than the averages of vehicles which passed the short test. For 1972-1974 model year vehicles, repair of failed vehicles yielded FTP HC averages which were greater than those of passed vehicles and FTP CO averages which were lower than those of passed vehicles. For 1975-1976 model years, the average FTP HC and CO emissions of repaired vehicles were still greater than those of vehicles which originally passed the short test.

3. Correlation of Changes in Emissions with Before Maintenance Levels, Engine Displacement, and Vehicle Mileage

A multiple regression analysis was performed for predicting change in FTP and short test emissions as a function of the before maintenance value, engine displacement, and mileage. The change in emissions was uncorrelated with mileage for all three emissions and all short tests. On occasion, the contribution from the CID term was significantly nonzero but for practical purposes this term could also be ignored in the predictive equations. Thus, of the factors considered, change in emissions was correlated with pre-maintenance emission levels and the ability to predict the change depended on the pollutant and short test.

A regression analysis was also conducted to predict change in FTP emissions as a function of pre-maintenance short test emission levels. The observed correlations were stronger for the Hot FTP and Federal Short Cycle tests than for the Federal Three Mode and Idle tests.

4. Correlation of Change in FTP Emissions with Change in Short Test Emissions

A regression analysis was performed to predict change in FTP emissions as a function of change in short test emissions for each of the short tests. The relationship was strongest for the Hot FTP test (r≈0.90) and weakest for the Idle (N) test (0.50<r<0.71 for HC and CO). The correlation coefficients of this analysis are greater than those for predicting change in emissions as a function of pre-maintenance levels. Thus, the ability to predict absolute FTP levels is enhanced if the prediction is based on a change in short test emissions rather than on pre-maintenance short test emissions for all short tests.

5. Effect of Relative HC to CO Failures on I/M Effectiveness

An analysis was performed to evaluate the effect of relative changes in the proportion of HC to CO failures at a fixed stringency factor on the first year inspection/maintenance benefits. Very little change in overall benefits occurred as a result of changing the HC/CO ratio from 10 to 0.1 at a stringency factor of 30 percent.

6. Costs, Frequency, and Types of Repair

Over 90 percent of all vehicles in this survey required adjustments to the idle RPM and idle A/F ratio to return the vehicle to recommended settings. Approximately 90 percent of the 1972-1974 vehicles and 70 percent of the 1975-1976 vehicles required timing adjustments. Failing vehicles had slightly higher frequencies of maladjusted idle RPM, idle A/F ratio, and timing.

The average cost of maintenance for 1975-1976 model year, all Phase I vehicles, was $26. This figure includes about $18 for the emission oriented tune-up, $2.50 for the repair of maladjustments and disablements, and $5.50 for the manufacturer recommended maintenance. The costs for the passing Phase I vehicles were not significantly different from those just quoted. Average total cost for the failing 1975-1976 vehicles was about $25.50 which included $23 for tune-up, $1 for repair of maladjustments and disablements, and $4.50 for manufacturer recommended maintenance. In the 1972-1974 model year vehicles, the tune-up costs are significantly larger (approximately $14 to $17 on the average) than those of the 1975-1976 vehicles. The average total cost for a

1972-1974 vehicle was $44. For a 1972-1974 vehicle passing the Idle (N) short test (Phase I vehicles) this cost was $39.50 while for a failing 1972-1974 vehicle (Phases I and II), it was $41.50.

The correlation of percent change in FTP emissions and maintenance cost was analyzed. The costs of maintenance are unrelated to percent emissions reductions for the 1975-1976 vehicles and are significantly (but weakly) correlated with reductions in the 1972-1974 model years.

7. Variability of Replicate Short Tests

Replicate determinations of all of the short tests were performed as a part of the test procedure. A pooled estimate of the standard deviation of the replicate determinations provided a measure of the repeatability of the various short tests. As a percentage of the mean, there was less repeatability for 1975-1976 vehicles than for the 1972-1974 vehicles. No consistent patterns of variability were observed in comparing short test, pollutants, and model year groupings. Typical coefficients of variation ($100 \, S/\overline{X}$) are approximately 20 percent with a low 5 percent and a high of 100 percent.

2.2 RELATIONSHIP BETWEEN FTP AND SHORT TEST EMISSIONS

1. Linear Regression Relationships

A regression analysis was performed to assess the ability of the short test emissions to predict the FTP emissions. The Hot FTP and the Federal Short Cycle emissions displayed a strong correlation with the FTP emissions, with correlation coefficients greater than 0.93 and 0.84, respectively, for each model year-pollutant combination. The predictive ability of the Federal Three Mode Test was intermediate ($0.60 \le r \le 0.88$) while that of the Idle (N) short test was weak ($0.19 \le r \le 0.71$). The observed correlations were generally consistent with those observed in vehicles operating at low altitudes but the predictive equations were significantly different. The correlation of FTP emissions with short tests was not improved by the addition of a term for vehicular mileage.

2. Contingency Table Correlation

The discriminatory ability of the short tests was investigated through a contingency table analysis. Using the short test pass-fail criteria and the Federal Standards for defining high and low FTP emissions, the percentage of vehicles erroneously classified by the short test cutpoint can be determined. An error of commission is defined as a short test rejection when the FTP emissions are less than the Federal Standard. An error of omission is defined as a short test acceptance when the FTP emissions are greater than the Federal Standard. The percentage errors of commission and omission were calculated for all short tests and for stringency factors of 10, 20, 30, 40, and 50 percent for both model year groups. In the Denver area, very few errors of commission occurred since most in-use vehicles fail the Federal Standards for CO and/or HC. In the 1972-1974 model years, none passed the CO standard and seven percent passed the HC standard. In the 1975-1976 model years, ten percent passed the CO standard and 32 percent passed the HC standard. Therefore, when the pass-fail criteria are based on all three emissions, the errors of commission are negligible and the percent errors of omission can be approximated by the percentage that passes the short test (the compliment of the stringency factor). The errors are reversed when only NOX is considered. In Denver, 95 percent of 1975-1976 and 83 percent of 1972-1974 vehicles pass the Federal Standards for NOX. Thus, NOX errors of commission are very common. For all four combinations of passing and failing the Idle (N) short test and Federal Standards, the means and standard deviations of FTP emissions are presented in the tables of Section 3 for the five stringency factors.

An impact measure was defined in terms of the percentage of excess emissions that are identified by the short tests at each stringency factor. For the Idle (N) and Federal Short Cycle tests at 40 percent stringency factors, approximately 65 percent of the emissions which exceed the Federal Standards will be identified by the short test. The Federal Short Cycle test had higher impact measures than did the Idle (N) test and the 1975-1976 vehicles had higher impact measures than the 1972-1974 vehicles.

3. Ability of Short Test to Identify the Highest FTP Emitters

To determine if the failed fraction of the population has significantly higher emissions than the passed as determined by the Idle (N) or Federal Short Cycle tests, the average emissions at each stringency factor were calculated for the four categories of pass/fail and FTP/short test. For all stringency factors, both model year groupings and both short tests, the average HC and CO emissions were significantly greater for the failed vehicles than for the passed vehicles.

The average emissions at each stringency factor of the failed vehicles were also compared with the corresponding worst x percent of the population. For stringency factor of 30 percent or more, the HC and CO averages of vehicles failed by the Federal Short Cycle test are 90 percent or more of the worst emitters' average. Similar averages for vehicles failed by the Idle (N) test are 80 percent or more of the worst emitters' average.

2.3 CORRELATION OF EMISSIONS WITH ENGINE CONDITION AND USAGE

1. Causes for High FTP Emissions

A sequence of diagnostic tests defined by the Clayton Manufacturing Company was applied to the emissions from the modes of the Federal Three Mode test. The diagnostics indicated that approximately 50 percent of the vehicles failing the federal HC standard had abnormally high HC emissions in the modes associated with failure of an ignition system component. Similarly, approximately 50 percent of the vehicles which failed the Federal CO standard had abnormally high CO emissions in modes whose cause is a gross error in the carburetor idle air fuel mixture.

2. Maladjusted Vehicle Systems

In the high altitude regions, maladjustment and/or disablement of emission related systems is common. The data from all Phase I test vehicles indicate that approximately 70 percent of the vehicles have at least one system maladjusted and/or disabled. This percentage is lower (66 percent) for the vehicles which pass the Idle (N) short test and, thus, higher (86 percent) for those which fail. Maladjustments and/or disablements are most common to the limiter caps and the timing (about 50 percent in the Phase I vehicles) and relatively rare for other systems (6 percent or less). The percentage of vehicles with maladjusted and/or disabled limiter caps, timing, and at least one system malperformance were obtained by manufacturer for 1975-1976 vehicles and by vehicular mileage for the model year groupings. No noteworthy differences were observed among these percentages.

3. Relationships Between Maladjustments and Emissions

The average standard deviation of the FTP emissions and fuel economy of the vehicles with and without maladjustments and/or disablements were obtained and compared for various groupings of the total data set. Most of the comparisons regarding manufacturers and vehicular mileage increments indicated no difference in emissions and fuel economy between the categories. However, fuel economy was higher for vehicles with timing maladjusted and lower for those with limiter caps maladjusted and/or disabled. Also, average CO was significantly larger for vehicles with maladjustments and/or disablements in at least one system.

No relationship was determined for identifying vehicles with FTP emissions greater than the Federal Standards with the various types of maladjustments and/or disablements. Similarly, no relationship was found between engine related owner responses to a questionnaire and the various types of maladjustments and disablements.

4. Relationship Between Maladjustments and Owner Maintenance Practices and Owner Perceived Performance Problems

A questionnaire regarding owner practices with regard to vehicle maintenance and performance problems was completed for each vehicle. The percentage of vehicles with maladjustments and/or disablement of the limiter caps, timing, or at least one emission related system and/or component was calculated for each response to pertinent questions. The comparisons did not indicate differences in owner maintenance practices or owner perceived performance problems for vehicles with maladjusted or disabled limiter caps, timing, and/or any other examined component.

5. Engine Parameter Settings

Percentages of vehicles with the engine parameters of timing, idle RPM, and idle CO outside of defined tolerances were determined for various data groupings. Among the all Phase I and passing Phase I vehicles, fewer General Motors vehicles were outside specifications than the other manufacturers. This difference did not hold for the failing vehicles, however. Thus, among General Motors vehicles engine parameters provide a degree of discrimination as to passing or failing the Idle (N) test that is not present in the vehicles of other manufacturers. These percentages were also determined for increments of engine displacement and vehicular mileage, but no conclusive trends were identified.

6. Relationship of Engine Parameter Settings with Emissions

Averages and standard deviations of emissions and fuel economy were calculated for vehicles within specification tolerances and outside specification tolerances for many groupings of the test data. For Phase I the HC and CO emissions for vehicles outside timing and/or RPM tolerances were significantly larger than for the vehicles within these tolerances. The differences were not significant in the passing Phase I vehicles or failing Phases I and II vehicles. Thus, the timing and idle RPM settings tend to discriminate between the pass-fail vehicles. For vehicles inside and outside idle CO tolerances, however, the differences in average HC and CO emissions were significant for the all Phase I and passing Phase I groups. Insufficient data were available for comparison in the failing Phases I and II groups of vehicles.

The correlation between changes in emissions due to maintenance and the change in adjustments of timing, idle RPM, and idle CO was investigated by a regression analysis. The correlations were poor although significantly different from zero.

SECTION 3

TECHNICAL DISCUSSION

This section contains a detailed description of the data base, analysis procedures, data summaries, and results of the study. First, the data available for analysis are discussed in terms of their source, range of applicability, and type. There are three primary objectives of the program and each of these is presented as a major subsection. The major objectives of the program are to determine the effects of inspection and maintenance on emissions, to determine the effectiveness of short tests in identifying high emitters, and to characterize maintenance and repair actions and costs.

3.1 DATA BASE

As part of its Emission Factor Programs, the EPA has measured the emissions and fuel economy of in-use light duty vehicles in the Denver area for several years. The Denver segment of the fiscal year 1974 (FY74) Emission Factor Program was expanded for this study to provide data relevant to the evaluation of inspection and maintenance programs. While a detailed description of the FY74 Denver Emission Factor Program can be found in Reference 1, a brief summary of the elements of the program which have impact on the interpretation of the I/M data analysis is presented in the following paragraphs. A description of the basic parameters that were measured and the data stratifications that will be used is also presented.

3.1.1 Selection of Vehicles

Considerable care is exercised to insure that the vehicles selected for testing in the Emission Factor Programs form a representative sample of the in-use vehicle population. In the FY74 Emission Program, the total sample was not representative of the total population of in-use vehicles but, rather, was selected to provide a representative sample of vehicles within each model year. This sampling philosophy was adopted to provide a large sample of 1975 and 1976 model year cars, thereby providing sufficient data for an early characterization of the newer generation of emission control devices. Thus, as a part of the FY74 Emission Factor Program, a random sample of Denver vehicles were selected from each of the 1972, 1973, and 1974 model years (Technology I vehicles), and 1975/76 model years (Technology II vehicles).

A profile of the in-use vehicles was produced based on national vehicle sales which characterized a representative sample by make, engine size, carburetor type, and transmission type for each of the model years. The test sample of in-use vehicles was then found by matching this profile as closely as possible using the following guidelines: (1) all vehicles were to be of the correct make and model; (2) at least 90 percent were also to be of the engine displacement specified; and (3) at least 70 percent were to be an exact match to the profile specifications.

Vehicle procurement was achieved primarily through mail contact with a large random sample of car owners in the Denver area. Every nth name on a computer file of vehicle owners in selected postal zip code areas received mailings which explained the program and provided a reply data card. The responses to mailed questionnaires provided information about the owner's vehicle and also indicated owner willingness to participate in the program. Approximately 85 percent of the test vehicles were selected through this procedure and the remainder (which had to meet a narrowing range of specific requirements) were located through the news media, automobile repair organization service files, used car lots, and other sources. Approximately 30 mailings were required for each vehicle finally selected.

The initial sample of Denver Emission Factor Program vehicles consisted of 117 automobiles. This sample was increased in two stages. First, an additional random sample of 77 automobiles were added to the 1975/76 model years and these cars were treated as Emission Factor Program vehicles. One of these vehicles was eliminated from the analyses of this report due to questionable emission values. This group of 193 vehicles comprise the sample defined as Phase I vehicles. Second, an additional representative sample of 470 vehicles representing the 1972-1976 model years was obtained through a selection procedure identical with that of the Phase I Emission Factor Program vehicles. This latter sample is defined as the Phase II vehicles.

Pass-fail selection criteria to identify high emitters (which will be discussed later) were developed and applied to all vehicles in Phase II. The criteria were selected to fail approximately 40 percent of the vehicles. The same pass-fail criteria were applied to the Phase I vehicles to obtain a failed sample similar to that of the Phase II sample. The number of automobiles that resulted in each combination of phase, model year, and pass-fail status is shown in Table 3.1. All Phase I vehicles were given a complete set of emission tests before and after maintenance as will be described in the next paragraph. However, only those Phase II vehicles which failed the selection criteria were given the complete set of emission tests. The Phase II vehicles which passed the criteria were immediately returned to their owners, and since no further evaluations of these vehicles were performed, they are not included in any of the analyses of this report.

3.1.2 Test Procedures

Each Phase I test vehicle was inspected upon delivery to the laboratory to insure that it could be safely run on the dynamometer and to determine its compliance with sample requirements. A few vehicles were rejected at this initial point. After acceptance, a sample of the fuel was taken for lead content analysis and pre-test operations were performed. The vehicle was then subjected to the before maintenance Evaluation Test Sequence. The Evaluation Test Sequence consisted of a variety of test procedures but for the I/M analysis the pertinent steps of the sequence areas follows:

1. 1975 Federal Test Procedure
2. Hot Start Federal Test Procedure
3. Federal Short Cycle
4. Two Speed Idle Test
5. Federal Short Cycle (replicate)
6. Federal Three Mode Test
7. Two Speed Idle Test (replicate)
8. Federal Three Mode Test (replicate)

Following the before maintenance Evaluation Test Sequence, an emission related Maladjustment and Disablement Inspection was performed. This inspection consisted of visual and functional tests of emission related components and systems to determine the extent of maladjustment and disablement to which the test vehicles had been subjected. Engine diagnostic checks were also performed to determine the condition of the electrical components (timing, dwell, spark plugs, ignition wiring, points, condenser, spark coil, etc.) and the engine vacuum system (vacuum signal lines, PCV valve, etc.). This diagnostic procedure also included an emission analysis to determine the amount of HC and CO in the exhaust at idle and at a no-load condition of 2250 rpm. Maintenance was then performed by the laboratory personnel on the vehicle which included restoring disabled components or systems, performing required periodic maintenance if appropriate and performing an emission oriented tune-up. In performing the maintenance, a limitation of $100 was placed on total emission related parts replacement and labor. The emission related tune-up returned the vehicle to emission specifications as appearing on the EPA required Engine Emission Control Specification label and in the service manuals. Since these specifications are primarily for low altitude regions, the emissions oriented tune-up was not necessarily optimum for the high altitude of the Denver region.

Following maintenance, the vehicles were again subjected to the Evaluation Test Sequence to determine the FTP and various short test emission levels. Upon completion of the after maintenance test sequence, the vehicles were returned to the owners.

Figure 3.1 presents a flow diagram of the Denver I/M Program procedures for Phase I vehicles.

The handling procedures for the Phase II vehicles differed from those of the Phase I vehicles only to the extent that an inspection test was performed to screen the low emitters from further testing. This test was similar to the Two Speed Idle Test except NOX emission measurements were not taken. The failure limits were based only on the HC and CO emission measurements at the low speed idle condition (curb idle in neutral). All vehicles which passed the limits were returned immediately to their owners with no further tests. Those which failed the limits were then subjected to the same handling procedures as those of Phase Figure 3.2 gives the flow diagram for Phase II vehicles.

3.1.3 Basic Parameters Measured and Stratifications to be Used

The basic data set relevant to the evaluation of a high altitude I/M program consists of six types of parameters:

1. FTP emissions
2. Fuel economy
3. Short test emissions
4. Maladjusted and disabled system identifications
5. Engine parameters
6. Cost of maintenance and repair

The purpose of this subsection is to define the general stratifications that are maintained throughout the study and to present pertinent comments regarding the basic data parameters.

The vehicles included in the sample represent the 1972 through 1976 model years. Since the vehicles of these model years involve both Technology I and Technology II emission control systems and since the two types have different emission characteristics, the data will always be stratified in terms of model year. The 1975 and 1976 model year vehicles are always grouped together due to the relatively few 1976 model year vehicles and due to the fact that both of these model year vehicles employ Technology II systems. The 1972, 1973 and 1974 model year vehicles are presented both separately and combined. All vehicles of these model years have Technology I systems, but the 1972 models were not certified to meet NOX standard. All three years had identical HC and CO Federal Standards. Combining the 1972-1974 model year vehicles into a single subpopulation provides a homogeneous subgroup of the total sample of cars since the HC and CO emissions of the Denver test vehicles do not differ significantly among the three model years and since the average NOX emissions for all three model years were below the 1973/74 standard.

As discussed in the previous paragraph, the test vehicles were obtained in two phases. All Phase I vehicles went through a before and after maintenance Evaluation Test Sequence, but only those Phase II vehicles which failed the screening test were subjected to any Evaluation Test Sequence. Thus, Phase II data only consist of failing vehicles and can only be combined with the failing vehicles of Phase I to form an unbiased sample of vehicles which fail the screening test.

Three samples of interest in the analysis of the Denver I/M data have been used throughout most of this report. All of the Phase I vehicles provide a representative sample of the Denver in-use vehicles for the four model years. The passing vehicles of Phase I provide a representative sample of all vehicles for each model year which meet the screening criteria. Finally, the combination of the failing vehicles of Phases I and II are combined to form a random sample of the population of vehicles which fail to pass the screening criteria.

Obviously, the last two of these populations are greatly dependent on the pass-fail screening criteria. The analysis of this study is dependent for the most part on a screening criteria designed to fail approximately 40 percent of the vehicles on the basis of HC and CO emissions obtained from the Idle (Neutral) Short Test. Specifically, a vehicle failed the inspection test if either the HC or CO Idle (N) emissions exceeded the following limits or cutpoints:

Model Year	Idle HC	Idle CO
1972-1974	400 ppm	5.5%
1975-1976	250 ppm	2.0%

The planned failure percentage which is assumed for any I/M program is known as the stringency factor. The effect on the change of emission levels for several stringency factors is considered for the Idle (N) test in Paragraph 3.2.1. It should be noted that different results would be expected if the pass-fail criteria were established in terms of one of the other short tests or if different cutpoints were used on the Idle (N) test. The method used in determining the cutpoints will also be discussed in Paragraphs 3.2.1 and 3.2.5.

The stratifications that result from model year, phase, and pass-fail categorizations as described above are generally maintained throughout the analysis. As a convenient reference, the number of vehicles in each relevant combination is as follows:

	All Phase I Vehicles	Passing Phase I Vehicles	Failing Phase I and Phase II Vehicles
1972	25	14	50
1973	27	16	53
1974	30	22	31
1972-1974	82	52	134
1975-1976	111	72	124

The basic or standard exhaust emission test was performed in accordance with the Federal Test Procedure. The FTP is comprised of cold transient, cold stabilized and hot transient portions. The 1975 FTP weightings were used in the calculation of the emissions for all vehicles. Similarly, when emission levels were compared to Federal Standards, the 1975 FTP equivalent of the 1973/74 standards were applied to all 1972-1974 vehicles (even though no NOX standard was in effect in 1972). The 1975 standards were applied to the 1975-1976 vehicles. For reference, the applicable Federal 49 State Standards are as follows:

Model Year	FTP	HC	CO	NOX
1972	1972	3.4	39.0	
1973/74	1972	3.4	39.0	3.0
1975/76	1975	1.5	15.0	3.1

A conversion between the 1972 FTP and the 1975 FTP depends upon vehicle mix, but approximately equivalent values for the 1972-1974 model year vehicles are:

	HC	CO	NOX
1972 FTP	3.4	39	3.0
1975 FTP	3.0	34	3.1

In conducting the emission tests for a particular vehicle, the amount of CO_2 emitted was measured in addition to the pollutants of HC, CO, and NOX. Since a fixed quantity of gasoline contains a known amount of carbon and the total carbon emitted was measured, the amount of gasoline used to traverse a fixed distance may be determined by the carbon balance method. The fuel economy data for each vehicle were calculated and recorded in terms of miles per gallon. The average fuel economy for a group of vehicles is defined as total miles divided by total fuel consumption. Since all vehicles are driven the same distance in the tests, it can be shown that average fuel economy in miles per gallon is the harmonic mean of the fuel consumed during the tests of the individual vehicles. Therefore, average fuel economy is reported in terms of harmonic means and standard deviations. Reference 5 gives further information on the method of statistical inference regarding the fuel economy parameter.

Emissions were also obtained using the Hot Start FTP, the Federal Short Cycle, the Federal Three Mode, and the Two Speed Idle Tests in each Evaluation Test Sequence. These latter emission tests are referred to as the short tests in this report and statements concerning their measurements will always identify the specific short test. It should be noted that while all of these tests are faster and cheaper than the full FTP, there is a wide range in their length and complexity. The following paragraphs give a brief description of each of these tests.

The Hot Start FTP is a mass emissions test similar to the FTP except that exhaust sampling is initiated from a hot engine start. Hot Start FTP emissions are comprised of the sum of the emissions from the transient and stabilized test portions of the full FTP divided by the distance traversed during the test portions (7.5 miles).

The Federal Short Cycle is a 9 mode mass emission test which uses the CVS measurement procedure. The test is preceded by a six minute soak period which begins after a sustained period of vehicle operation. The Federal Short Cycle test time is 125 seconds at an average speed of 21.7 mph (0.7536 mi.). The dynamometer loading and transmission shift points are identical to those of the FTP.

The Federal Three Mode Test employs tailpipe sampling by volumetric procedures at each of three modes of vehicle operation. The three steady state modes simulate the average power which occurs at high speed (50 mph), low speed (30 mph), and idle (neutral). The results from each of the three modes are measured separately.

The Two Speed Idle Test is a two mode test which entails volumetric HC, CO and NOX emission measurements while the engine is operated at approximately 2250 rpm with no load and at idle in neutral. The engine is operated in each of these modes until the emissions are stable. The idle mode of the Two Speed Idle Test was used to screen the Phase II vehicles as to its exclusion (pass) or inclusion (fail) in further testing.

In addition to the measured emission levels as determined by the tests, data were collected defining those emission control systems which had been maladjusted and/or disabled on each vehicle. Analysis of this data was performed in an attempt to determine the effect of maladjustments and disablements of specific components and systems on emissions and fuel economy. Certain engine parameter settings were also obtained during the inspection and maintenance task, both before and after maintenance. The engine parameters were used in an attempt to isolate high emission vehicles and to correlate emissions with data on the extent of maladjustment of emission components. Finally, estimates were recorded for the emission related tune-up costs, maladjustment and disablement costs and the manufacturers recommended maintenance costs.

3.2 EFFECTIVENESS OF I/M

In the evaluation of the effectiveness of an I/M program in reducing automobile pollutants, seven distinct areas of analysis were established. These include:

1. The determination of first year effectiveness for idle I/M programs with different stringency factors.
2. The comparison of after maintenance emissions with emissions of vehicles passing the cutpoints.
3. The correlation of changes in emissions with before maintenance levels, engine displacement, and mileage.
4. The relationship between changes in FTP emissions with changes in short test emissions.
5. The effect of relative HC to CO failures on I/M effectiveness.
6. The cost, amount, and type of repairs as a function of passing or failing the short test.
7. The variability of FTP and short test results.

The following paragraphs address each of these areas by presenting a statement of the objectives followed by the analysis and the conclusions.

3.2.1 Estimation of Idle (N) I/M Program Effectiveness

Objective: Determine the average first year maintenance effectiveness for different stringency factors in an I/M program based on the Idle (N) short test.

The basic data pertinent to this analysis include the FTP emission and fuel economy data taken before and after maintenance. Tables 3.2 and 3.3 present the average and standard deviations, respectively, for all three populations and the model year groupings. The percent effectiveness values given in Table 3.2 are equivalent to those expected in a mandatory maintenance program since all vehicles received maintenance. Tables 3.4 to 3.8 have been generated by assuming stringency factors of 10 percent to 50 percent. In each case, the Phase I vehicles were used to determine the appropriate idle test cutpoints. Cutpoints were determined by assuming that a vehicle that is twice the short test standard for HC is equally as bad as a vehicle which is twice the short test standard for CO. The short test standard is obtained by regressing the FTP emissions on the idle emissions (using Phase I and Phase II vehicles) and finding the idle equivalent value of the FTP standards. The short test standards are given below along with the number of HC and CO failures observed in the Phase I data.

Stringency Factor	Model Year	Combined Cutpoints HC	CO	NOX	Actual No. of Failures HC	CO	NOX
10	72-74	739	9.99	-	7	4	0
	75-76	1199	5.59	-	1	10	0
20	72-74	599	8.19	-	9	10	0
	75-76	1199	3.49	-	1	22	0
30	72-74	599	6.29	-	9	21	0
	75-76	1199	2.39	-	1	32	0
40	72-74	389	5.39	-	15	31	0
	75-76	394	1.69	-	5	43	0
50	72-74	314	4.29	111	18	35	1
	75-76	299	0.99	-	8	56	0

It should be noted that in calculating the standards this way, the 40% stringency factor is not equivalent to the one used as a screening criteria for Phase II. Although there are an infinite number of combinations of HC/CO short test cutpoints which could give a 40% stringency factor, the one given in the table above is equivalent in concept to the assumption used in the formulation of Appendix N. Table 3.9 contrasts the results of the previous tables with the first year benefits listed in Appendix N. Tables 3.10 to 3.24 present similar information for the idle test emissions, the cold bag emissions of the FTP, and the stabilized bag emissions of the FTP. Examination of these tables indicates that effectiveness measures are dependent upon the driving sequence of concern. In CO hot spots, the FTP may not be the driving cycle of most interest.

In addition to the comparisons of before and after maintenance emission levels, two other comparisons are of interest which are more difficult to make. It is of interest to determine if the Technology II vehicles benefit more or less than the Technology I vehicles from an I/M program. Further, given that both HC and CO are reduced by an I/M program, the comparative amount of reductions of the two need to be established. A set of statistics that would account for the variability in observed percentage changes is required to perform these comparisons. The means and standard deviations of the percent change in each vehicle was calculated and these values are presented in Table 3.25 for all three groups of data.

First, consider the question of whether Technology I and II vehicles benefited equally from the maintenance actions. This hypothesis can be tested by a comparison of average percent differences for 1972-1974 vehicles against those of the 1975-1976 vehicles. This test indicates that in the all Phase I and passing Phase I populations, the average percent reductions of both HC and CO were not significantly different between the Technology I and II vehicles. In the failing Phases I and II vehicles, however, the Technology II vehicles experienced a significantly greater average percent reduction than did the Technology I vehicles for both the HC and CO. These tests were conducted at the 95 percent level of confidence. Thus, failing 1975-1976 model year vehicles benefit more from the maintenance action than do the failing 1972-1974 vehicles.

In the comparisons of the HC reductions to the CO reductions, the conclusions depended on the model years. In 1975-1976 model year vehicles, the average percent reductions were not significantly different for HC versus CO emissions for all three populations of vehicles. In the 1972-1974, however, the average percent reduction for CO is significantly greater than that of HC for all three populations. This analysis indicates that HC and CO benefits of Technology II vehicles due to maintenance are equal while those of Technology I vehicles are greater for CO than HC. Since this latter conclusion held for the group of all passing vehicles as well as the group of all failing vehicles, the result is independent of the screening ability of the Idle (N) short test.

3.2.2 Comparison of After Maintenance Emissions With Passed Vehicles Emissions

Objective: Determine if the vehicles are repaired to just pass the short test standards, to the FTP standards, or to the mean of the passed vehicles.

This study does not simulate a real I/M program in that the prescribed maintenance included the repair of diagnosed maladjustments and disablements as well as an emission related tune-up. Thus, mechanics were not merely attempting to get a vehicle to pass a specific set of short test standards. As a result, the repaired vehicle emissions measured in this study could be expected to be lower than those that would occur in a real world I/M program. With this in mind the tables presented earlier (Tables 3.4 - 3.24) were examined to determine how the repaired emissions compared to those of the passed vehicles. The results are summarized in Table 3.26 for HC, CO, and NOX emissions of the FTP, Idle (N), cold transient, and cold stabilized by model year groupings.

Several conclusions can be drawn from the comparison of average emissions of failed vehicles after repair with those of the passed vehicles, the short test cutpoints, and the applicable standards. The means of the Idle (N) emissions of repaired vehicles are below the cutpoints but the repaired vehicle Idle (N) means tend to be greater than the passed vehicle Idle (N) means. All average FTP HC and CO means exceed Federal Standards while the NOX averages are all less than Federal Standards. For the 1972-1974 model year vehicles, repair of failed vehicles yield HC averages which were greater than those of the passed vehicles for the FTP and cold stabilized portion and less than those of the passed vehicles for the cold transient portion of the test. The average FTP, cold transient, and cold stabilized CO emissions, however, were less in the repaired vehicles than in the passed vehicles. For the 1975-1976 model year vehicles, all average HC and CO emissions were greater for the repaired vehicles than for those which passed. The repair for both model year groupings did reduce the average FTP, cold transient, and cold stabilized NOX emissions below that of the passed vehicles.

3.2.3 Correlation of Changes in Emissions with Before Maintenance Levels, Engine Displacement, and Vehicle Mileage

Objective: Determine the relationship between the changes in FTP and short test emissions due to maintenance with the before maintenance levels, the vehicle engine displacement (CID), and the vehicle mileage.

An examination of the emission reductions of each vehicle which received maintenance indicates that these reductions vary widely from vehicle to vehicle. This is displayed in the standard deviations of the average percent reductions given in Table 3.25, the before versus after maintenance values of Figures 3.3 through 3.6, and the histograms of percent change in emissions and fuel economy of Figures 3.7 through 3.10.

The diagonal lines on Figure 3.3 through 3.6 represent no change due to maintenance. It is obvious from Figures 3.3 and 3.4 that not all vehicles benefit from the maintenance action. (The degree of repeatability of the FTP test is being ignored. This assumes that the scatter from replicated tests is balanced in the total presented picture even though individual data points could be in error.) Approximately 25 percent of the vehicles had higher HC and/or higher CO after maintenance than before. It is also interesting to note that some higher emitters, as well as lower, had their emissions increased. The histograms of percent change in emission and fuel economy reductions due to maintenance of Figures 3.7 through 3.10 display the distributions of the observed percent reductions for the two model year groupings. The histograms for the 1972-1974 vehicles display less variation than those of the 1975-1976 vehicles but this may be attributed to the higher before maintenance emissions of the 1972-1974 vehicles.

Any ability to predict which vehicles will obtain the greatest reduction from maintenance would enhance the attractiveness of an I/M program. (This analysis could also examine specific diagnostic parameters or parametric changes but these have been treated separately in a later problem statement.) A regression analysis was performed on the relationship between the absolute change in emissions and the before maintenance level, engine displacement, and mileage. This analysis was performed for each FTP pollutant, short test pollutant, and FTP fuel economy. A stepwise regression analysis was calculated in which the dependent variable is first estimated by the strongest correlating independent variable (if significant) and more terms are added to the equation if they provide a significant increase in the predictive ability of the regression equation. The results of this analysis indicated the reduction of pollutant levels are correlated with the pre-maintenance emission measurement, are not correlated with vehicle mileage, and are weakly correlated with CID for some short tests and emissions. Table 3.27 presents the significant regression results for each pollutant and for fuel economy for the two model year groupings for all Phase I vehicles. A similar analysis was performed to determine if percent reduction could be predicted as a function of pre-maintenance value and CID. For every pollutant, model year, and test the correlation of percent reduction was weaker than that for absolute reduction.

A regression analysis was also performed to determine if absolute change in FTP emissions could be predicted as a function of pre-maintenance short test emission levels. These results are summarized in Table 3.28 which presents the regression equations and correlation coefficients for each pollutant, model year grouping and short test combination for all Phase I vehicles. In this analysis the multiple modes of the Federal Three Mode and Idle tests were combined in a single equation. Due to the use of the Idle (N) short test in screening high emitters, a separate equation was also calculated for this single mode of the Idle short test. All observed relationships were significant except for predicting the change in FTP NOX emissions as a function of the Idle (N) short test values. The relationships are generally stronger for the Hot FTP and Federal Short Cycle tests than for the Federal Three Mode and Idle tests. For HC and CO, between 45 and 75 percent (100 r^2) of the variation in change in FTP levels is explained by the correlation with the Hot FTP and Federal Short Cycle tests. Less than 25 percent of the variation in NOX reduction is explained by the pre-maintenance short test values.

3.2.4 Correlation of Change in FTP Emissions with Change in Short Test Emissions

Objective: Determine the relationship between change in FTP emissions due to maintenance with change in the short test emissions.

The ability of a short test to predict the FTP is considered to be a measure of the FTP/ST correlation. The question posed here is a different one. It is possible to predict changes in the FTP from changes in the short test and still not be able to predict absolute FTP levels. Such a situation can readily occur if FTP change and short test change are not highly correlated with their pre-maintenance emission levels.

The results of this analysis are summarized in Table 3.29 which presents the regression equations for all combinations of model year groupings, short tests, and pollutant for all vehicles of Phase I. The correlation coefficients of this table are in every case greater than the corresponding correlation coefficients of Table 3.28 for predicting change in FTP emission as a function of the pre-maintenance short test level. Thus, the ability to predict absolute FTP levels is enhanced if the prediction is based on a change in short test emission rather than on pre-maintenance short test level.

3.2.5 Effect of Relative HC to CO Failure on I/M Effectiveness

Objective: For a fixed overall stringency factor of 30%, determine the effect of relative changes in HC/CO failures on the first year inspection/maintenance benefits.

In the development of the first year I/M benefits given in Paragraph 3.2.1, the stringency factor cutpoints were determined by a complex procedure. For each short test emission value from each vehicle, a normalized score was developed by dividing the observed short test value by a "standard". For each emittant and model year grouping, the "standard" was defined as the predicted short test value at the Federal Standard when average short test values are predicted as a linear function of FTP values. All normalized values for the three emittants were combined, ordered, and the desired percentile determined. The cutpoints for each of the emittants were determined from that of the exact percentile determined (e.g., a CO value) and from the nearest normalized values of the other emittant which lie above the exact percentile. If an emittant is not represented in this latter group, the cutpoint is independent of that emittant at that stringency factor. The cutpoints that were obtained based on the combination of emittants are presented in Table 3.30. Again, note that the cutpoints calculated by this method for the Idle (N) 40 percent stringency are not those used in the screening of the values into pass-fail populations.

Many other schemes could be devised for deriving cutpoints based on a combination of emittants which will fail the desired number of vehicles. To examine the effect of changing these criteria, a single stringency factor of 30% was selected. The HC normalized score was multiplied by the following factors: 10, 5, 2, .5, .1. In each case, a new set of 30 percent stringency factor cutpoints were determined. Table 3.31 displays the cutpoints and Table 3.32 summarizes the benefits for the different cases. Very little change in overall benefits occurred as a result of changing the HC/CO ratio.

3.2.6 Costs, Frequency, and Types of Repair

Objective: Determine the difference between costs, frequency, and types of repair as a function of vehicle pass/fail status.

Due to the scarcity of vehicles which passed the FTP standards, an analysis based on stratification defined in terms of the Federal Standards would be meaningless. Therefore, the data were stratified in terms of passing or failing the Idle (N) short test and analyzed with respect to cost, frequency, and type of repair.

The maintenance actions performed on each vehicle during tune-up were summarized to indicate the type of action required for each system. Tables 3.33, 3.34, and 3.35 display the summaries for all vehicles in the Phase I, pass Phase I, and failing Phases I and II groups, respectively. As expected, the rates of component replacement, repair and adjustment are greater for the failing Phases I and II vehicles.

Sufficient maintenance actions were performed on the idle RPM, idle air/fuel ratio, and dwell to warrant a further division of these systems by manufacturer (for 1975-1976 model year vehicles) and by the two model year groupings. These data are presented in Tables 3.36 through 3.41. The observed differences in percentages of vehicles which required the various categories of tune-up action were not significant when comparisons were made among manufacturers, model years, or the pass-fail grouping.

The costs incurred in performing the maintenance actions were categorized as being either for parts, labor and total as applied to emission related tune-up cost, maladjustment and/or disablement costs, and manufacturer recommended maintenance costs. For each of the Phase I and II groupings of vehicles, the mean and standard deviation for all of these costs were calculated for each model year, for each manufacturer, and for vehicle mileage by model year groupings. These data are presented in Tables 3.42 through 3.50. The average total maintenance cost of the passing Phase I vehicles is not significantly different from that of the failing Phases I and II vehicles. The newer Technology II vehicles cost less on the average (about $26) to maintain than did the Technology I vehicles (about $44). Labor represented approximately 75 percent of the total costs. Costs for repairing maladjustments and/or disablements are small compared to the total maintenance cost.

With respect to manufacturer, the average cost of maintaining the foreign vehicles was less than that of the American vehicles among the all Phase I and passing Phase I groups. None of the differences among manufacturers was significant for the failing Phases I and II vehicles.

When the cost data are considered by vehicular mileage, the 1972-1974 vehicles with more than 50,000 miles have higher average costs for the tune-up than the lower mileage vehicles (which display an increasing trend with mileage). Note that the cost of manufacturer recommended maintenance influences total costs so that these comparisons should be made on the basis of tune-up cost. Among the 1975-1976 vehicles, the general trend of increasing tune-up costs with mileage is also present in the all Phase I and passing Phase I groups, but the average tune-up costs for the all failing 1975-1976 vehicles by mileage increments are not significantly different.

Given a population of vehicles, the data from these tables can be used to estimate the cost of an inspection/maintenance program for a given stringency factor. Table 3.51 presents a summary of the tune-up costs for the passed and failed Phase I vehicles as determined for different stringency factors and the Idle (N) short test. For either model year grouping the tune-up costs are greater for the failed vehicles than for the passed vehicles at all stringency factors. The difference between average pass and fail costs for 1975-1976 vehicles, however, is approximately constant for all stringency factors. For the 1972-1974 vehicles, however, the difference increases as the stringency factor decreases. For the 1972-1974 vehicles, the greatest polluters (as determined by Idle (N) emissions) tended to require more expensive maintenance.

An analysis was performed to determine the relationship of the percent change in FTP emissions and fuel economy with the three components of maintenance cost and the total maintenance cost. The results of this analysis are presented in Table 3.52 which contains the correlation coefficients for each combination of the emissions and cost element for the two model year groupings and the stratifications of vehicles by Phase I, passing Phase I, and failing Phases I and II. The correlations which are significantly non-zero at the 95 percent level of confidence are indicated by an asterisk. The correlation of maintenance costs with percent emission reduction is, in general, very weak. For the failing Phases I and II vehicles and for any group of 1975-1976 vehicles, there is virtually no correlation of maintenance costs with percent emission reduction or percent change in fuel economy. For the 1972-1974 vehicles of all Phase I and passing Phase I groups, the correlation with tune-up costs, manufacturers recommended maintenance costs, and total costs is fairly consistently significant, although weak. Therefore, the costs of maintenance are unrelated to percent emission reductions of the relatively new 1975-1976 model year vehicles and are significantly (but weakly) correlated with reductions in the 1972-1974 model year vehicles.

3.2.7 Variability of Replicate Short Tests

Objective: Estimate the degree of variability when the short tests are repeated under identical conditions. Determine if this vehicle variability is a function of absolute level, mileage, or maintenance state.

As a part of the test sequence performed on each of the vehicles, replicate determinations were made for each short test. (The hot portions of the FTP were treated as a replicate of the Hot FTP test.) These replicates were used to estimate the variability that is present when the short tests are repeated under identical experimental conditions. Before estimating the variability, however, preliminary analyses were performed to determine the appropriate measure of the variability.

To determine if the replicate variability was a function of absolute level, the standard deviation of each pair of Hot FTP and Idle (N) measurements was calculated and plotted as a function of the average of the two points. A plot of the standard deviation divided by the average versus the average was also generated. These figures indicated that the degree of variability is not a function of the emission level for the Hot FTP and Idle (N) short tests. Further, the ratios of individual standard deviations to averages tend to provide a biased measure of the variability as those ratios are larger for the lower average emissions.

The preliminary analysis led to the use of a pooled estimate of the standard deviation of replicate measurements. This standard deviation was calculated by estimating the variance of each vehicle and then pooling the estimates to obtain a single overall value. This procedure accounts for the differences that are present between the vehicles and depends on the assumption that the within vehicles (replicated) standard deviation is equal for all vehicles.

Table 3.53 presents the replicate standard deviations and coefficients of variation for the three pollutant measurements from all short tests and the two model year groupings for the all Phase I vehicles. The coefficient of variation was calculated as the ratio of the pooled standard deviation to the grand average of both measurements from all vehicles. In the preliminary analysis, some of the replicated values from eight vehicles were identified as outliers and these eight vehicles were not included in further replicate analyses. To indicate the influence of the outliers, Table 3.53 also contains the replicate standard deviations and coefficients of variation for the 1975-1976 Phase I vehicles with three vehicles eliminated. (No 1972-1974 Phase I vehicles were identified as containing outliers.) The Idle (N) short test reflects a large reduction in the variance for HC and CO due to eliminating the three outliers but all other variances are essentially unchanged. Therefore, the exclusion of the outlier vehicles will provide a more realistic estimation of the replicate variation without influencing the conclusions drawn in the analyses.

A comparison of the replicate variability for model year groupings indicates that the 1975-1976 vehicles have greater variability in the CO measurements than do the 1972-1974 vehicles for all short tests. This conclusion holds in an absolute sense as measured by the standard deviations and, since the CO emissions are lower in the 1975-1976 vehicles, in the relative sense as measured by the coefficients of variation. In most cases for HC, the 1975-1976 vehicles had less variability than the 1972-1974 vehicles in the absolute value but approximately equivalent variability when expressed as a percentage of the mean. The Hot FTP and Federal Short Cycle HC determinations were more repeatable for the 1972-1974 vehicles. The Idle (N) HC determinations were more repeatable for the 1975-1976 vehicles in absolute measure but approximately equal in relative variance. The replicate variability of the NOX measurements from the two model year groupings was approximately equal for the Hot FTP and Federal Short Cycle tests, was less for the 1975-1976 vehicles for the Federal Three Mode, and was greater for the 1975-1976 vehicles for the Idle tests.

Table 3.54 compares the replicate variability of the vehicles which passed the Idle (N) short tests with those that failed. For the HC determinations, the passing vehicles displayed greater repeatability than the failing vehicles for the Federal Short Cycle and Idle tests, but the results were mixed for the Hot FTP and Federal Short Cycle tests. The replicate variability of the CO and NOX measurements indicate that the results of pass-fail comparison depend on the particular short test and model year combination. The Federal Three Mode had less variation in determinations for passing 1972-1974 model year while the 1975-1976 order was not consistent for all three modes. The Hot FTP and Federal Short Cycle CO variability was less for failing vehicles than for passing for both model year groupings. The Idle (N) CO determination variability was less for passing vehicles than for failing.

To test for a possible bias between the replicate short test determination, a Student's t statistic was calculated for the average difference between first and replicate determination. The observed Student t values are presented in Table 3.55. The pollutant, model year grouping, and short test combinations which indicated a statistically significant bias are indicated on the table. In particular, there was a consistent bias observed for the Idle (N) and Idle (2250) determinations of HC and CO in which the second determination was larger than the first. No explanation could be found for the possible biases observed in these data.

3.3 FTP/SHORT TEST CORRELATION

A key feature in the application of an inspection and maintenance problem is the ability to identify the vehicles which are high emitters and which will benefit from an emissions oriented maintenance. In recent years, all new automobiles have been subjected to Federal emission standards which are expressed in terms of FTP emissions. Since all new vehicles were designed to be capable of meeting these standards, the FTP standards provide natural pass-fail criteria for determining the vehicles which should benefit from the maintenance actions. FTP emissions, however, are time consuming and relatively expensive to measure. Thus, the use of the FTP in a large scale inspection program would be impractical. Several short tests are available which could be used in a large scale program. However, their ability to identify the high FTP emitters in high altitude areas needs to be established.

3.3.1 Linear Regression Relationships

Objective: Assess the strength of the relationship between the pre-maintenance short test emissions and the pre-maintenance FTP emissions. Determine if this relationship is affected by the ability to pass the Idle (N) screening criteria.

Plots of before maintenance FTP and short test emissions are presented in Figures 3.11 through 3.31. These figures provide an indication of the strength and functional form of a predictive FTP/short test relationship. The FTP/short test relationship was measured quantitatively by a regression analysis assuming a linear model.

There are two common quantitative measures of the strength of the relationship between variables. The correlation coefficient, r, is a standardized index between ±1 which summarizes the degree of linear relationship. Values close to plus or minus one indicate strong relationships (the sign is indicative of the sign of the slope) and values close to zero indicate weak linear relationships. A useful interpretation of the correlation coefficient can be inferred from the fact that $100r^2$ is the percent reduction of the variance of the FTP emissions after accounting for the linear relationship. A second measure is the estimate s(e), the standard deviation of differences between the predicted and observed values. Approximately 68 percent of the FTP emissions would be expected to lie within one s(e) of the predicted value and approximately 95 percent would be expected to lie within 2s(e). As r decreases in absolute value, s(e) increases rapidly to the standard deviation of the FTP emissions.

Tables 3.56 through 3.58 present the results of the regression analysis for the Phase I, passing Phase I, and failing Phases I and II vehicles, respectively. The equations of Table 3.56 are representative of the in-use population of vehicles for these model years. The tables of passing and failing vehicles are presented for comparative purposes.

The correlations displayed in Table 3.56 indicate a strong relationship between FTP emissions and the Hot FTP and the Federal Short Cycle emissions. At least 85 percent (r^2) of the variability of the FTP emissions is explained by the correlation with the Hot FTP short test emissions for all pollutants and both model year groupings. At least 71 percent (r^2) of this variability is explained by the correlation with the Federal Short Cycle emissions. The Federal Three Mode test provided as good or better predictions of the FTP results than the Idle tests for all pollutants and both model year groupings. The Federal Three Mode test, however, did not equal the predictive ability of the Hot FTP or Federal Short Cycle tests for any pollutant by model year combination. The standard errors, s(e), provide a direct measure of the uncertainty of a prediction and indicate the possible discrepancies that could result from a prediction of an FTP level from a short test measurement. The results for 1972-1974 are generally consistent with those for 1975-1976 vehicles. The equations reflect the differences in overall emission levels between the groupings and generally the correlation coefficients agree. The FTP HC versus Federal Three Mode HC correlation is less for 1975-1976 vehicles and the Idle and Idle (N) CO correlations are less for 1972-1974 vehicles.

In comparing the relationships for vehicles which fail the Idle (N) short test with those that pass (Tables 3.57 and 3.58), no general conclusion results. For the Hot FTP and Federal Short Cycle tests the correlation coefficients are larger for the failing vehicles but the standard errors are not necessarily smaller for the failing vehicles. This can result due to a larger degree of variability of the FTP emissions for the population of failing vehicles. For the Federal Three Mode, Idle, and Idle (N) short tests there is no consistent pattern between the passing and failing vehicles.

Table 3.59 presents a summary of regression results obtained from an analysis of 1975 model year vehicles operating at low altitudes, Reference 6. The strength of the FTP/short test correlation is approximately equal for the high and low altitudes. The resulting regression equations, however, are significantly different with respect to slopes and intercepts.

It is apparent from Figures 3.11 through 3.31 that, except for possibly the Hot Start FTP and Federal Short Cycle tests, other sources of variability will have to be accounted for to improve the predictive capability. In an effort to determine if vehicular mileage had a significant influence on this predictive capability, a regression analysis was performed with FTP emissions being predicted as a function of short test emissions and mileage. The results of this analysis are summarized in Table 3.60 in which the partial correlation coefficients of mileage with FTP emissions are presented, after accounting for the correlation with short test emissions. As a group, this relationship is strongest for CO emissions in 1975-1976 model year vehicles, but in no case did the addition of the mileage term significantly increase the predictive ability of the short test. For example, the largest partial correlation coefficient is 0.25 which occurred three times. The increases in the multiple correlation coefficient obtained by adding the mileage term for these cases were 0.01, 0.03 and 0.03. Increases of this magnitude would have no significant influence on predictive capability. Therefore, a more extensive summary of these results is unwarranted.

3.3.2 Contingency Table Correlation

Objective: Contingency table analysis is useful if the correlation of interest involves the ability to predict whether an observation belongs to a specific group rather than to predict its exact value. In FTP/short test relationships, the ability to predict FTP passage or failure based on a knowledge of the short test value is of most interest. The determination of the number of errors and the percent of vehicles which are properly identified for various stringency factors is part of the contingency table approach for correlation estimation.

The Federal Standards apply to FTP emissions and can be used to divide the vehicles of a particular group (e.g. 1972-1974 model years) into two categories, pass or fail. Similarly, the cutpoints of a short test will divide the vehicles into categories of pass and fail. When the Federal Standards and the short test cutpoints are applied simultaneously, the vehicles are divided into four categories: pass short test, pass FTP; pass short test, fail FTP; fail short test, pass FTP; fail short test, fail FTP.

Such groupings can be visualized quite readily in Figures 3.11 through 3.31. To demonstrate, Figures 3.32 and 3.33 again show the FTP versus Idle (N) HC and CO emissions plots, this time the cutpoints used in this program and the 1975 FTP equivalents of the 1973/1974 Federal Standard are superimposed. The Federal Standards and short test cutpoints divide the plane into the four regions as defined in the previous paragraph. Since vehicles to the right of the vertical cutpoint line fail the short test, reducing the stringency factor shifts the vertical cutpoint line to the right (i.e. fail fewer vehicles).

If the objective is to identify those vehicles which exceed the Federal Standards, the vehicles in the pass-pass (PP) and fail-fail (FF) regions have been correctly identified. However, the vehicles in the other two regions have been erroneously classified. An error of commission (EC) is defined as that of failing a vehicle on the basis of the short test when the FTP emissions are less than the Federal Standard. An error of omission (EO) is defined as passing a vehicle on a short test when the FTP emissions exceed the Federal Standard. As can easily be realized from Figure 3.33, few errors of commission are possible on 1972-1974 model year test vehicles since most cars of these model years exceed the CO Federal Standard. Since errors of commission might cause needless maintenance expenses and since errors of omission would fail to identify the high emitters for maintenance, an analysis was conducted to determine the frequency of these errors for all of the short tests and five stringency factors. This analysis is referred to as the contingency table analysis. In addition, the percentage of the total pollution contribution to be removed from the air by correctly identifying high emitting vehicles at a particular cutpoints is the air quality impact at that cutpoint. The air quality impact is investigated for various cutpoints.

Before presenting the results of the contingency table analysis, several comments are in order concerning the method of determining the cutpoints for specific stringency factors. Only the set of all Phase I vehicles was used in the derivation of the cutpoints. The Phase II vehicles were not used since they were pre-screened and are representative only of the population of vehicles that would fail a 40 percent stringency factor Idle (N) short test. The same procedure was used to determine cutpoints for each of the short tests so no distinction among short tests is necessary in describing the methodology.

Cutpoints were determined to obtain stringency factors of 10, 20, 30, 40, and 50 percent for each emittant considered individually and for the emittants considered collectively. When the emittants are considered individually, the cutpoints were simply determined by ordering or ranking the values from a short test and recording the values which correspond to 10 percent exceeding that value, 20 percent exceeding that value, etc. That is, the cutpoints are merely the non-parametric sample estimates of the percentiles of the observed distribution of emissions. The cutpoints for the individual emittants, the short tests and the model year groupings are presented in Table 3.61.

A more complex procedure was required to derive cutpoints which will fail a given percentage of the total population based on a combination of emittants. This procedure was described in detail in Section 3.2.5 and summarized in Table 3.30.

The above procedures for determining cutpoints will fail the prescribed percentage of vehicles on the short test. The contingency table for each stringency factor will provide estimates of the percentage of vehicles in the four combinations of passing or failing the short test and FTP standards. To measure the potential impact on pollutant levels by performing maintenance on those vehicles which fail the short test, a measure of the aggregate emission behavior of the vehicles in each category of the contingency table is required. An impact measure as described in Reference 6 was calculated for each stringency factor of the Idle (N) and Federal Short Cycle Tests for the two model year groupings. This impact measure is computed by the following steps:

(1) Each emission is divided by its Federal Standard to provide a dimensionless emission level. Use of dimensionless emissions allows aggregation of different emissions.

(2) Each dimensionless emission is reduced by 1.0. This provides a measure of the excess over the standard.

(3) All negative values are set equal to zero. This recognizes that all cars which meet the federal standards (i.e. have negative scores) have legal emissions and are assigned equal impact.

(4) Within a pass-fail category, the total impact score is obtained by summing the scores of all vehicles within the category.

(5) For the vehicles which failed the short test at each stringency factor, the impact is defined as the ratio of the summation in the FF category to the total of the FF and EO categories. (Since no 1972-1974 vehicles and only eight 1975-1976 vehicles passed the Federal Standards, the impact measures for the PP and EC categories were not calculated.)

This definition of the impact for a short test-stringency factor combination essentially measures the emissions from vehicles which fail the short test as a proportion of the total emissions from all vehicles which exceed the Federal standards. The actual reduction in emissions also depends on the efficacy of the maintenance actions in reducing the emission levels.

Tables 3.62 and 3.63 present the errors of omission and commission that would be made in the use of the Idle (N) test at various stringency factors for the 1972-1974 and 1975-1976 model years, respectively. Due to the extent of the high HC and CO FTP emissions in the Denver area, errors of commission for these emittants are extremely rare with respect to HC and did not occur for CO. Since all vehicles exceeded the Federal CO standards, the cutpoints merely separate these vehicles into two categories for the 1972-1974 model year vehicles: fail short test and FTP and errors of omission. The same separation also occurs on the combined emittants table since the CO value always exceeds the standard. For these model years, approximately the same phenomena occurs for HC emissions since the vehicles are separated into three categories and the pass-pass category contains only six vehicles (7.3 percent).

Similar results were obtained for the 1975-1976 model year vehicles, but the errors of omission are reduced somewhat due to the fact that more of the 1975-1976 vehicles passed the Federal Standards. At the 50 percent stringency rate for the combined emittants discrimination, errors of omission occurred in 41 percent of the vehicles.

The errors of commission are high and errors of omission are low when the cutpoints are determined on the basis of NOX only. This merely reflects the fact that FTP NOX emissions in Denver are generally low as compared to the Federal Standard.

These tables indicate that in the Denver area, errors of commission will be at an acceptable level for HC, CO, and all pollutants combined regardless of the desired stringency factor. Further, it would appear that the stringency factor would be approximately equal to the compliment of the percentage errors of omission for HC, CO, and all pollutants combined.

The impact measure as defined above was calculated for the Idle (N) and Federal Short Cycle for stringency factors of

10, 20, 30, 40, and 50 percent. The resulting values are presented in Tables 3.64 and 3.65. As the stringency factor increases, the proportion of detected aggregate emissions exceeding Federal Standards also increases as was expected. The change in the impact measure was greater, however, for a change in stringency from 10 to 30 percent than for a change from 30 to 50 percent. The Federal Short Cycle test had higher impact measure than the Idle (N) test and the 1975-1976 vehicles had higher impact measures than the 1972-1974 vehicles.

3.3.3 Ability of the Short Test to Identify the Highest FTP Emitters

Objective: Demonstrate that the emissions from the failed vehicles of the population were significantly larger than those of the passed vehicles.

If it is assumed that for cost or public reactions, an I/M program will force maintenance on some fraction of the entire population, a question of interest is whether the failed fraction of the population has significantly higher emissions than the passed fraction. To address this question, means and standard deviations of the emissions at each stringency factor were calculated for the four categories of FTP and Short Test pass/fail. The results for the Idle (N) test are summarized in Tables 3.66 through 3.71 and for the Federal Short Cycle test are summarized in Tables 3.72 through 3.77 for each model year grouping and for failure rates based on the combined pollutants.

The average HC and CO emissions are significantly greater for the vehicles that failed the short test than for the vehicles that passed for all stringency factors, for both model year groupings, and for both short tests. The average NOX emissions are equivalent for the failed and passed vehicles as determined by the Idle (N) test but the passed vehicles of the Federal Short Cycle test have larger average NOX emissions than do the failed vehicles.

To present similar data for the cold portions of the FTP tests, Tables 3.78 through 3.83 present averages and standard deviations of the cold transient emissions for each stringency factor as determined by the Idle (N) short test and the four categories of pass-fail. Tables 3.84 through 3.89 present analogous data for the cold stabilized emissions. For the average cold transient emissions, the distinction between passing and failing average HC and CO of the 1972-1974 vehicles was not significant at the high stringency factors. The difference was significant for the 1975-1976 vehicles at all stringency factors. The NOX average cold transient emissions were also not significantly different for the two populations of vehicles. For the cold stabilized emissions, average HC and CO were significantly larger for the failed vehicles for all stringency factors and both model year groupings. NOX averages, however, tended to be larger for the passing vehicles than for the failing.

The previous analyses demonstrate that the vehicles which fail the short tests have higher FTP, cold transient, and cold stabilized HC and CO emissions than those which pass the short test. It is also of interest to compare the average emissions at each stringency factor of vehicles which fail the short tests with the average emissions from corresponding stringency factor defined in terms of the FTP, cold transient, and cold stabilized emissions. That is, the worst x percent emitting vehicles were identified by using the combined pollutant method on the FTP emissions and the averages and standard deviations of each pollutant were calculated for these vehicles. The process was repeated using the cold transient and cold stabilized emissions to define the worst polluting vehicles. Table 3.90 presents the resulting averages and standard deviations for each pollutant and model year for stringency factors of 10, 20, 30, 40, and 50 percent. These averages represent the FTP emissions of the worst polluters (as determined on the FTP) and their comparison with Tables 3.66 through 3.89 provide an indication of whether or not the highest emitters are being detected.

The HC and CO averages at each stringency factor of the Federal Short Cycle test compares favorably with that of the worst emitters. For stringency factors of 30 percent or more, the Federal Short Cycle average is 90 percent or more of the worst emitters' average. For the Idle (N) test, the HC and CO averages tend to be less than the corresponding averages using the Federal Short Cycle as the discriminating short test, and, hence, there is more difference between the worst emitters and those identified by the Idle (N) short test at the stringency factors. For stringency factors of 30 percent or more, the Idle (N) averages are at least 80% of the worst emitters' average for the FTP and cold stabilized emissions. The agreement for the cold transient emissions is not as good, particularly for the 1972-1974 model year vehicles. The NOX averages display the typical high altitude trends. The worst emitters (as determined previously by HC and CO) have lower NOX average emissions than the averages as determined for the corresponding Federal Short Cycle stringency factors. The Federal Short Cycle NOX averages, in turn, are less than those of the Idle (N) NOX averages.

3.4 RELATIONSHIPS BETWEEN EMISSIONS/ENGINE CONDITION/USAGE

In addition to the basic data on the emissions and costs of maintenance actions, data was also collected which defines the state of each vehicle before and after maintenance actions. The analyses of these data are presented in the following paragraphs.

3.4.1 Causes for High FTP Emissions

Objective: Determine the causes for high FTP emissions to provide proper mechanic training inputs, and determine whether future technology vehicles will be more resistant to areas that have caused previous problems.

In an effort to determine the probable causes of high FTP emissions, the diagnostic tests similar to those defined by the Clayton Manufacturing Company were applied to the vehicles which failed the Federal Standards. These Clayton diagnostics are expressed in terms of failures of specific modes of the Clayton Key Mode Test. Although this test was not performed on most of the Denver I/M vehicles, the diagnostic criteria were applied to the emissions from the Federal Three Mode test. Both the Federal Three Mode and the Clayton Key Mode are loaded steady state tests. The diagnostics and the identification of the causes are presented in Tables 3.91 and 3.92 for HC and CO, respectively.

As can be seen from Table 3.91, the use of the diagnostics requires a determination of "abnormally high" HC and CO emissions in all three modes of the Federal Three Mode test. In the following analysis, "abnormally high" is defined as the 90th percentile of the respective pollutant for only those vehicles which passed the 1975 Federal Standard for that pollutant.

The results of this analysis categorizes the vehicles into probable causes of high emissions and are presented in Tables 3.93 and 3.94 for the 1972-1974 vehicles, and in Tables 3.95 and 3.96 for the 1975-1976 vehicles. With respect to vehicles failing the HC standard, approximately 50 percent also had abnormally high HC emissions in the modes associated with the type 2 causes (failure of an ignition system component). This was true for the vehicles of both model year groupings. Approximately 50 percent of the vehicles failing the Federal CO standard also had abnormally high CO emissions in the modes associated with type 3' causes and approximately 30 percent had abnormally high CO emissions in the modes associated with type 1' causes. Since gross error in the carburetor idle air fuel mixture adjustment is associated with both of these type causes, it is concluded that this is the probable cause of the high CO emissions.

3.4.2 Maladjusted Vehicle Systems

Objective: Investigate the causes of poor field emission performance to provide input for the design of improved vehicle systems.

A common phenomenon in the high altitude regions is for vehicles to have engine systems adjusted differently from manufacturers' specifications or to be totally disabled. Information was recorded on the maladjustment or disablement of certain engine systems on the vehicles of this study. Table 3.97 presents the percentages of vehicles which had maladjusted and/or disabled systems for all Phase I vehicles, passing Phase I vehicles, and failing vehicles of Phases I and II. Approximately 50 percent of the Phase I vehicles had the limiter caps and/or the timing out of adjustment, and 70 percent had at least one of the components or systems maladjusted and/or disabled. Since individual vehicles may have had more than one component or system maladjusted and/or disabled, the categories are not mutually exclusive. The failing vehicles of Phases I and II had a significantly higher percentage of vehicles with maladjusted/disabled limiter caps and timing than did the passing Phase I vehicles.

The number of vehicles with maladjustments and disablements of the limiter caps and timing was large enough to permit comparisons between manufacturers and between increments of vehicle mileage. Table 3.98 presents the percentage of vehicles of each manufacturer that had maladjusted and/or disabled emission-related system/components. The differences in these percentages between the vehicles of different makes are not significant. The sample sizes for some comparisons, however, are too small for definite conclusions.

The percentage of vehicles with maladjusted or disabled limiter caps and/or timing are presented by vehicular mileage increment for the model year groupings due to the large discrepancy in mileages between these populations. This added, but necessary, stratification reduced sample sizes even further. The percentages are presented in Tables 3.99 and 3.100. No distinct mileage trends were detected in either of the model year groupings.

3.4.3 Relationships Between Maladjustments and Emissions

Objective: Determine if the maladjustments can be related to emission levels and fuel economy to provide information for public and mechanic training and to assess the possible use of a diagnostic emissions inspection.

To compare the emissions of vehicles with disablements and/or maladjustments of limiter caps, timing, and at least one system in a vehicle to those without, the average and standard deviations of the emissions and fuel economy of these two groups were calculated for the Phase I vehicles. The data were stratified by manufacturer and also by vehicular mileage for each model year grouping. These data are presented in Tables 3.101 through 3.106. Many comparisons can be made using these tables, but the with versus the without maladjustments and disablements comparison for manufacturers is summarized in Table 3.107 and for mileage increments and model year groupings in Table 3.108. These tables present values of the Student t statistic for the test of significance of the equality of two means. Those comparisons which indicate a significant difference at a 95 percent level of confidence have been indicated with an asterisk. Positive values indicate the average with maladjustments and disablements is greater than the average without. Most of the comparisons resulted in the conclusion that the differences were not statistically significant. For the sample of all vehicles, fuel economy was significantly higher for vehicles with timing maladjusted and significantly lower for those with limiter caps maladjusted and/or disabled. The average CO emissions were significantly larger for vehicles with maladjustments and/or disablements in at least one component/system and for vehicles with disabled limiter caps.

An attempt was made to use discriminant analysis to determine whether the various types of maladjustments and disablements were correlated with high FTP emissions where high FTP emissions were defined as those greater than the Federal Standards. This analysis was not conducted beyond the initial stages for two reasons. First the number of vehicles which had FTP HC and CO emissions below Federal Standards was far too small for meaningful analysis. The categorical type variables on which discrimination depended would have required much larger sample sizes than those available. Secondly, comparatively few of the vehicles had maladjustments and/or disablements of systems other than the limiter caps and timing. Any discrimination would have to come from these systems and a preliminary analysis showed that percentages of vehicles with and without maladjustments and disablements were approximately equal for vehicles with emissions above and below the Federal Standards. Therefore, this type of multivariate analysis was not pursued further.

3.4.4 Relationship Between Maladjustments and Owner Practices

Objective: To assess the possible efficacy of a public education program, determine if maladjustments or disablements are related to owner practices.

As part of the data collection procedure each owner was required to complete a questionnaire regarding use, maintenance, and engine characteristics of the vehicle. The percentage of vehicles with maladjustments and/or disablements of the limiter caps, timing, or at least one system was calculated for each response. The questions related to engine performance for which enough diversity of answers were given to provide comparisons are summarized in Table 3.109 for all failing Phase II vehicles and in Tables 3.110 and 3.111 for the 1972-1974 and 1975-1976 model years, respectively. Note also that all answers to a question are not necessarily included. This questionnaire was only completed by the Phase II vehicle owners so the vehicles represented by these questionnaire responses have failed the Idle (N) short test. None of the comparisons of percentages for different responses are noteworthy. In fact, there is a high degree of consistency across all of the questions.

3.4.5 Engine Parameter Settings

Objective: Determine if the extent of maladjustments of the engine parameter settings of timing, idle RPM, and idle CO displays significant trends with respect to manufacturer, CID, or mileage.

The engine parameters of timing, idle RPM, and idle CO measured before maintenance were compared to fixed levels to determine the number of vehicles which were within the specification tolerances. If timing and idle RPM were within ±2 degrees and ±150 RPM, respectively, of manufacturers' recommended settings, the parameter was defined as within specification tolerances. Idle CO was defined as within tolerances if the tailpipe idle CO measurement was less than 0.5 percent.

The percentage of 1975-1976 vehicles with the pre-maintenance timing, idle RPM, and idle CO outside tolerances were calculated for each manufacturer, for each of five vehicular mileage increments and for each of three classes of engine displacement. These percentages are presented in Tables 3.112, 3.113, and 3.114 for each of the three samples of vehicles. Among the all Phase I and passing Phase I vehicles, fewer General Motors vehicles were outside specification tolerances than the other manufacturers. Among the failing Phases I and II vehicles, however, the General Motors vehicles have approximately the same percentages outside tolerances as do the other manufacturers.

The outside tolerance percentages are presented in Table 3.113 for vehicles in vehicular mileage increments. The only distinct trend among the mileage categories is the decreasing percentage outside of tolerances for the Idle RPM parameter. However, due to the small number of vehicles which do not meet the tolerances for this parameter and the relatively small number of vehicles in each mileage increment, this trend can only be considered tentative.

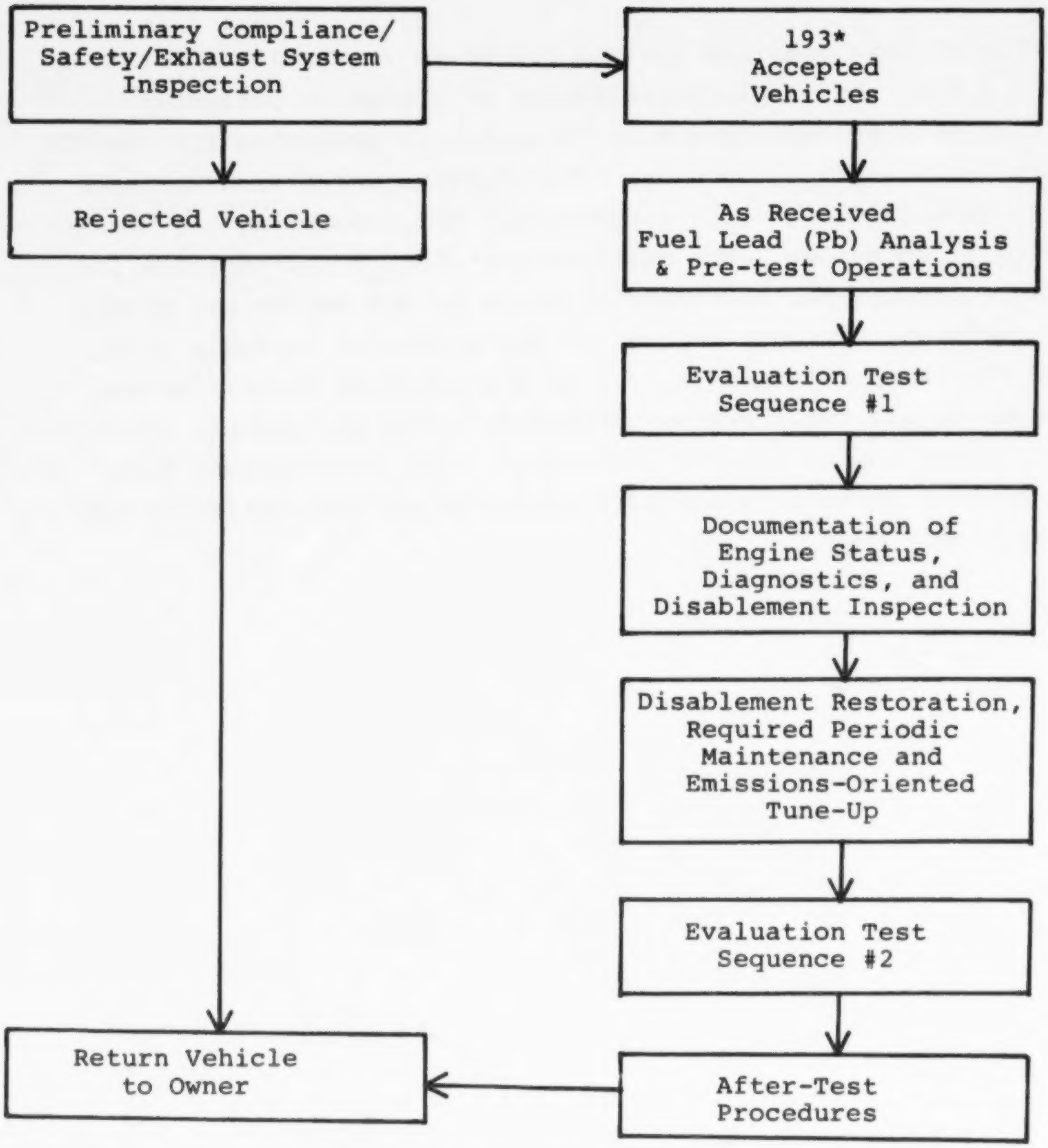
The percentage of vehicles outside engine parameter tolerances by engine displacement groups are presented in Tables 3.114. Again, the results are inconclusive.

3.4.6 Relationship of Engine Parameter Settings with Emissions

Objective: For use in estimating repair benefits, investigate the relationships between emissions and average engine parametric settings.

Tables 3.115 through 3.120 present the averages and standard deviations of FTP emissions and fuel economy for 1975-1976 vehicles within specification tolerances and outside of specification tolerances for each manufacturer, a composite for all vehicles and for all three populations. In general, tests for the difference of means for the individual manufacturers would not be meaningful due to small sample sizes. Student's t values for testing significance for all pairs in which there were ten or more vehicles in both averages are presented in Table 3.121. An asterisk indicates a significant difference at the 95% level of confidence. For the all Phase I vehicles, the average HC and CO emissions were significantly larger for vehicles outside the timing and idle RPM tolerances and also for vehicles outside the idle CO tolerances. When only those vehicles which passed in Phase I are considered, the differences in the averages for these are not significant for the vehicles within and outside timing and idle RPM tolerances, but are for the idle CO. Similarly, for all failing vehicles, the differences in the average emissions are not significant for the vehicles within and outside timing and idle RPM tolerances. Insufficient vehicles within tolerance prohibit the significance test for the idle CO tolerance averages.

The correlation between percent change in emissions and fuel economy before and after maintenance with the changes in adjustments of timing, RPM, and idle CO was determined by means of a stepwise regression. Tables 3.122 and 3.123 summarize the results of this analysis for all the Phase I vehicles. First, in Table 3.122, the simple correlations of change in parameter setting with percent change in emissions is presented for the FTP, short tests and fuel economy. The stepwise regression analyses selected significant engine parameters for predicting the percent change in emissions. The multiple correlation coefficients for these equations and the identification of the engine parameters and the order of their importance are presented in Table 3.123. None of the correlations have a good predictive capability and changes in all three engine parameters are significantly related to at least one of the FTP pollutants. The correlations with the percent changes in the Idle (2250) short test emissions are particularly weak.


Preliminary Compliance/ Safety/Exhaust System Inspection
193* Accepted Vehicles
Rejected Vehicle
As Received Fuel Lead (Pb) Analysis & Pre-test Operations
Evaluation Test Sequence #1
Documentation of Engine Status, Diagnostics, and Disablement Inspection
Disablement Restoration, Required Periodic Maintenance and Emissions-Oriented Tune-Up
Evaluation Test Sequence #2
Return Vehicle to Owner
After-Test Procedures

* Does not include one vehicle eliminated from the analysis of this report due to questionable emissions.

Figure 3.1. Phase I Flow Diagram of Denver Inspection/ Maintenance Evaluation Task Vehicles.

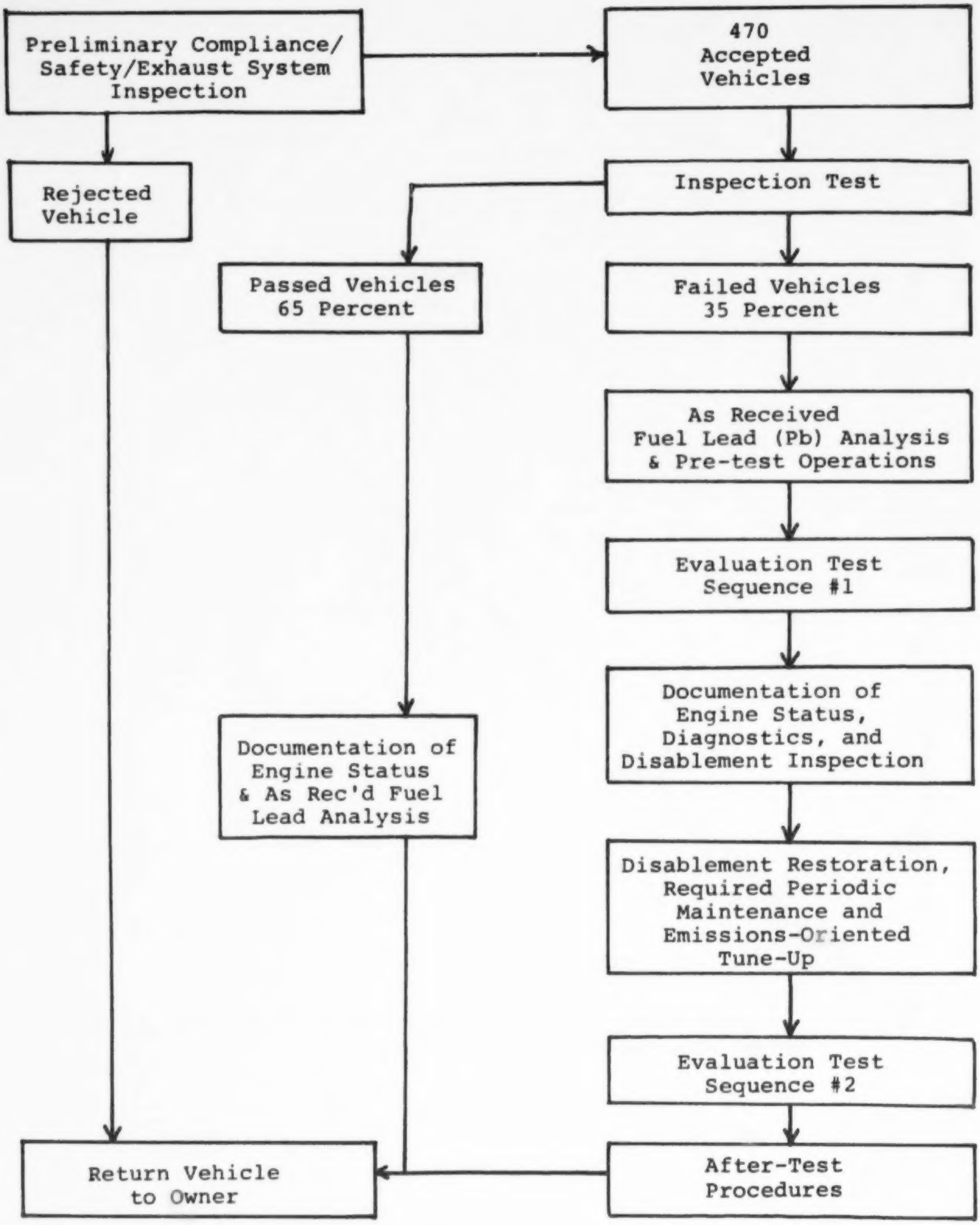

Preliminary Compliance/ Safety/Exhaust System Inspection
470 Accepted Vehicles
Rejected Vehicle
Inspection Test
Passed Vehicles 65 Percent
Failed Vehicles 35 Percent
As Received Fuel Lead (Pb) Analysis & Pre-test Operations
Evaluation Test Sequence #1
Documentation of Engine Status, Diagnostics, and Disablement Inspection
Documentation of Engine Status & As Rec'd Fuel Lead Analysis
Disablement Restoration, Required Periodic Maintenance and Emissions-Oriented Tune-Up
Evaluation Test Sequence #2
Return Vehicle to Owner
After-Test Procedures

Figure 3.2. Phase II Flow Diagram of 470 Vehicles Used in the Denver Inspection/Maintenance Evaluation Task.

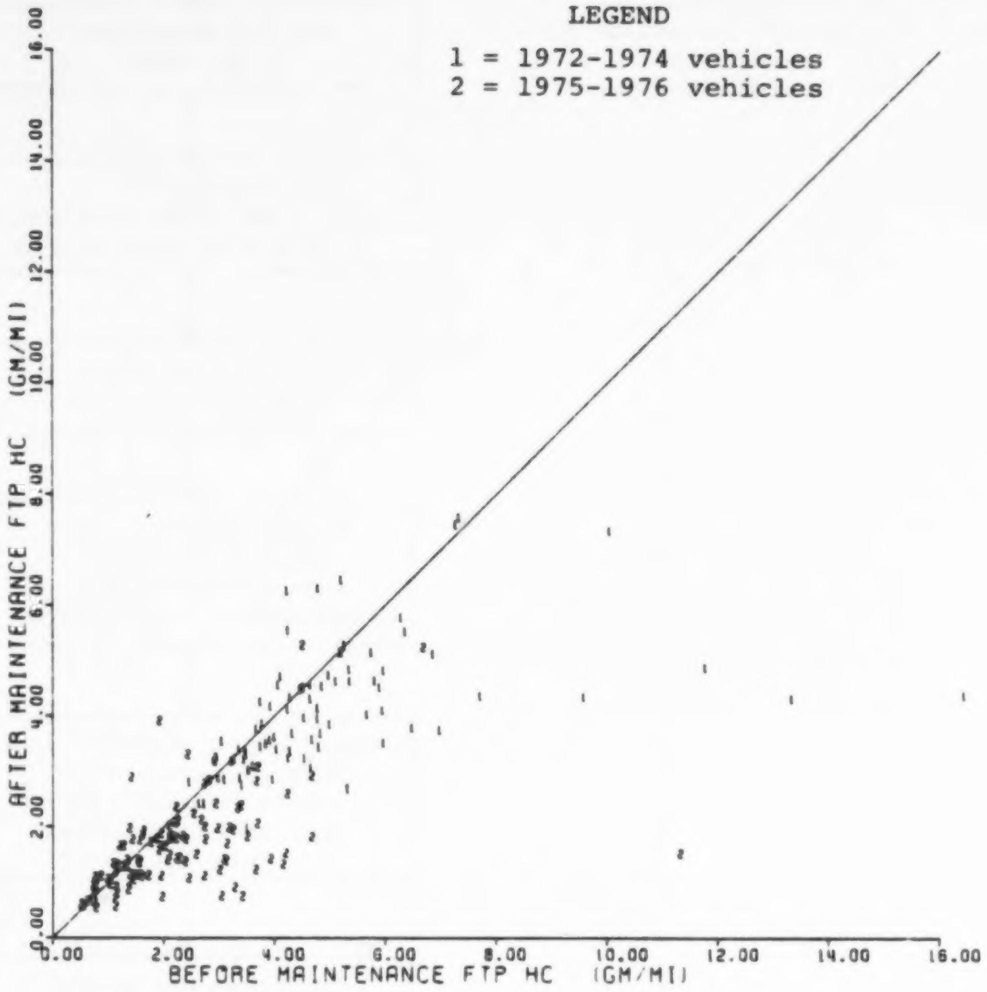


Figure 3.3. Before Maintenance FTP HC versus After Maintenance FTP HC.

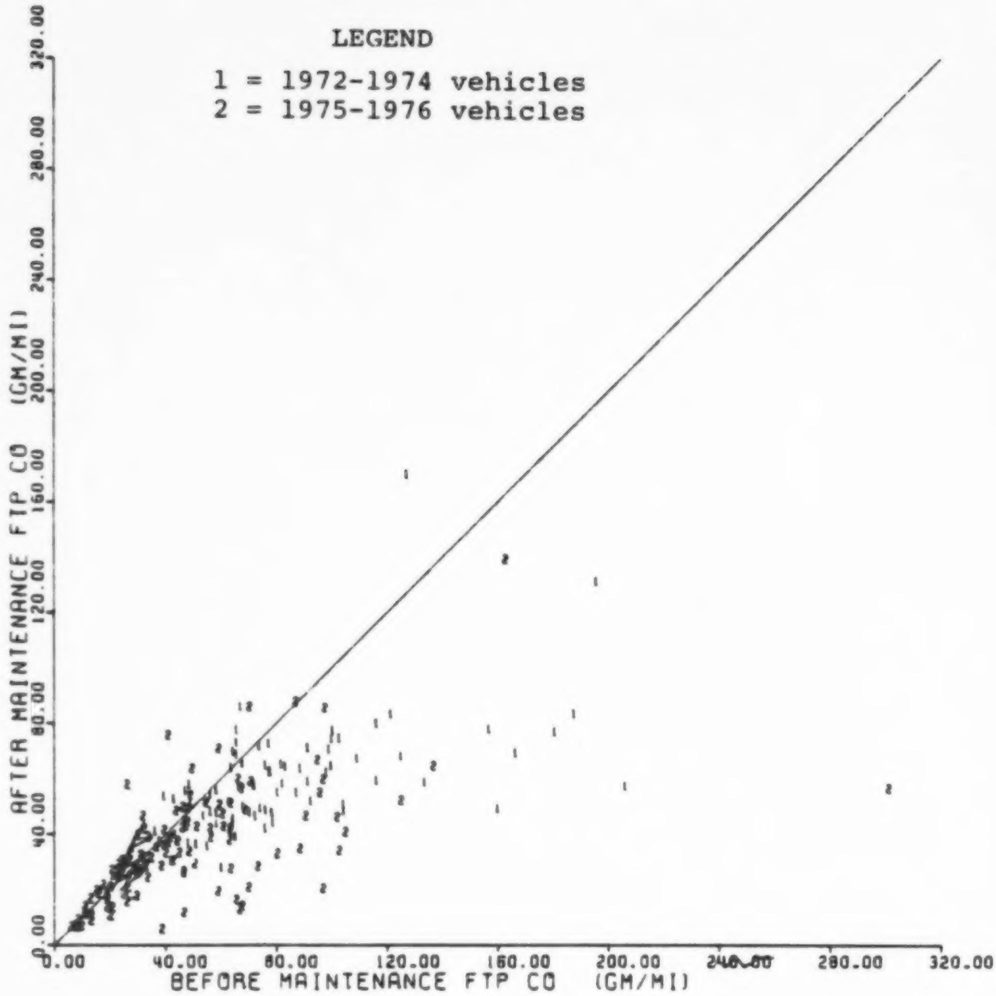


Figure 3.4. Before Maintenance FTP CO versus After Maintenance FTP CO.

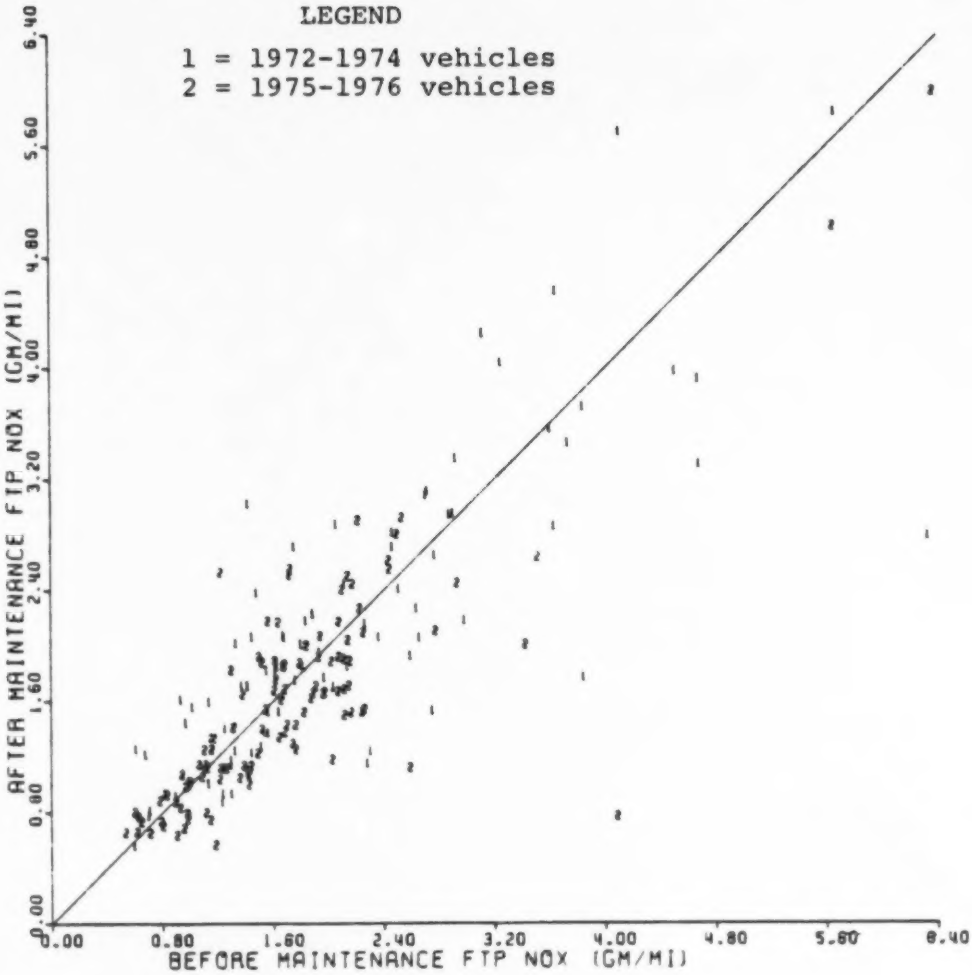


Figure 3.5. Before Maintenance FTP NOX versus After Maintenance FTP NOX.

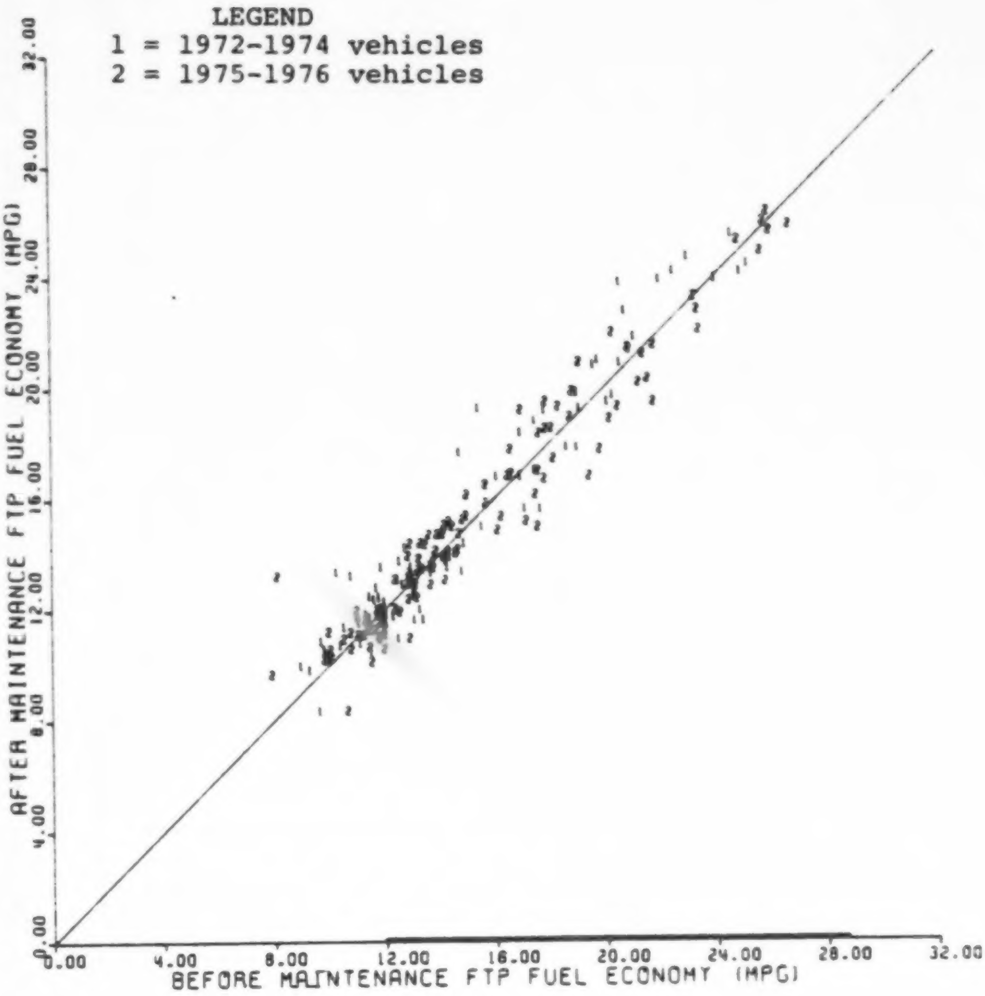


Figure 3.6. Before Maintenance Fuel Economy versus After Maintenance Fuel Economy.

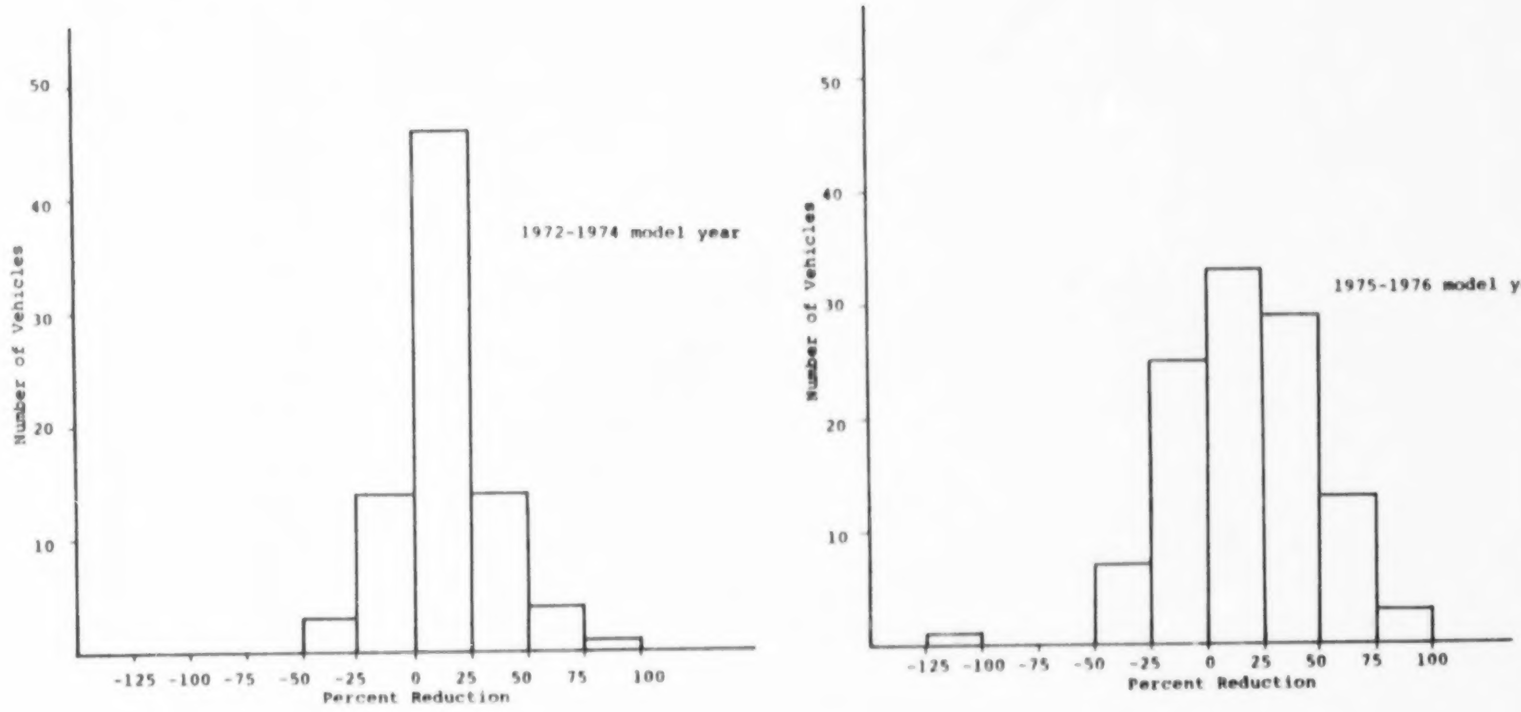


Figure 3.7. Percent Reduction in 1975 FTP HC Emissions due to Maintenance - All Phase I

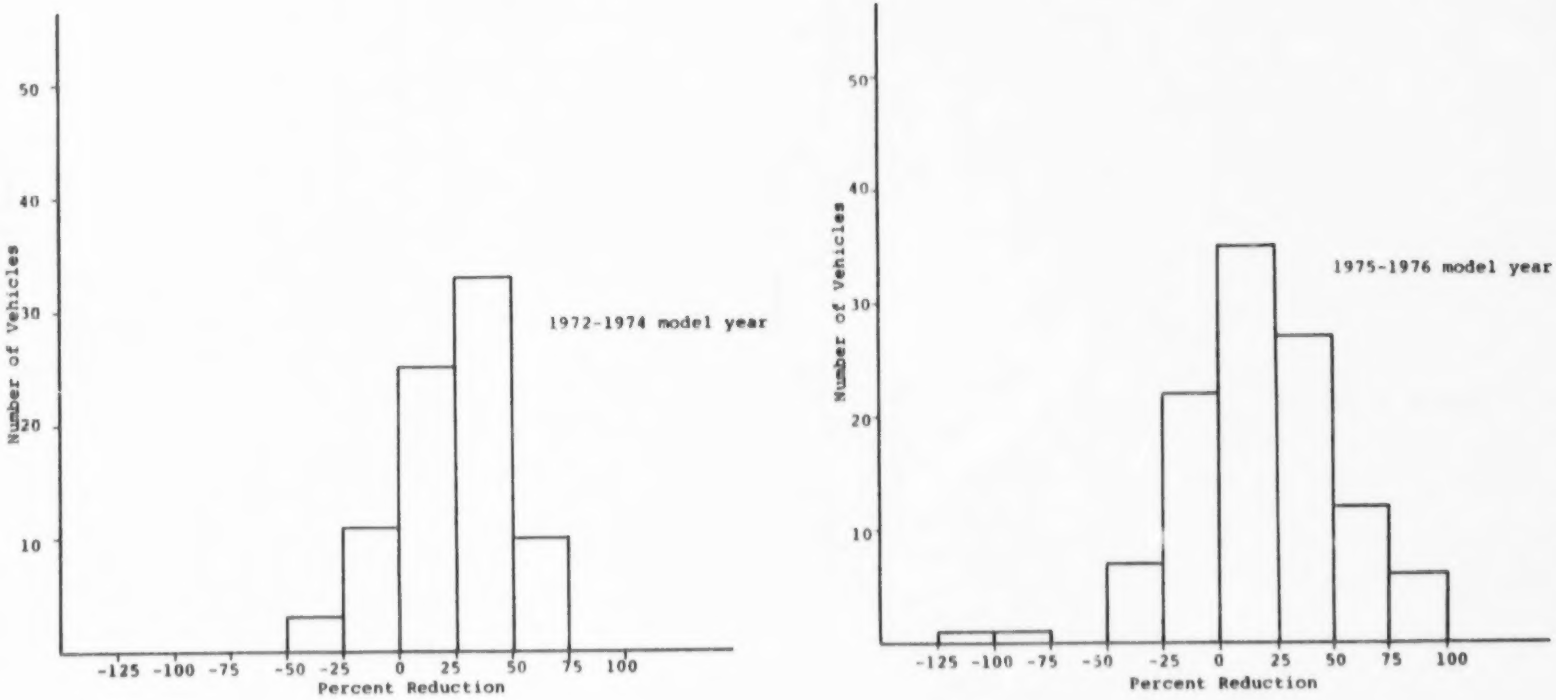


Figure 3.8. Percent Reduction in 1975 FTP CO Emissions due to Maintenance - All Phase I

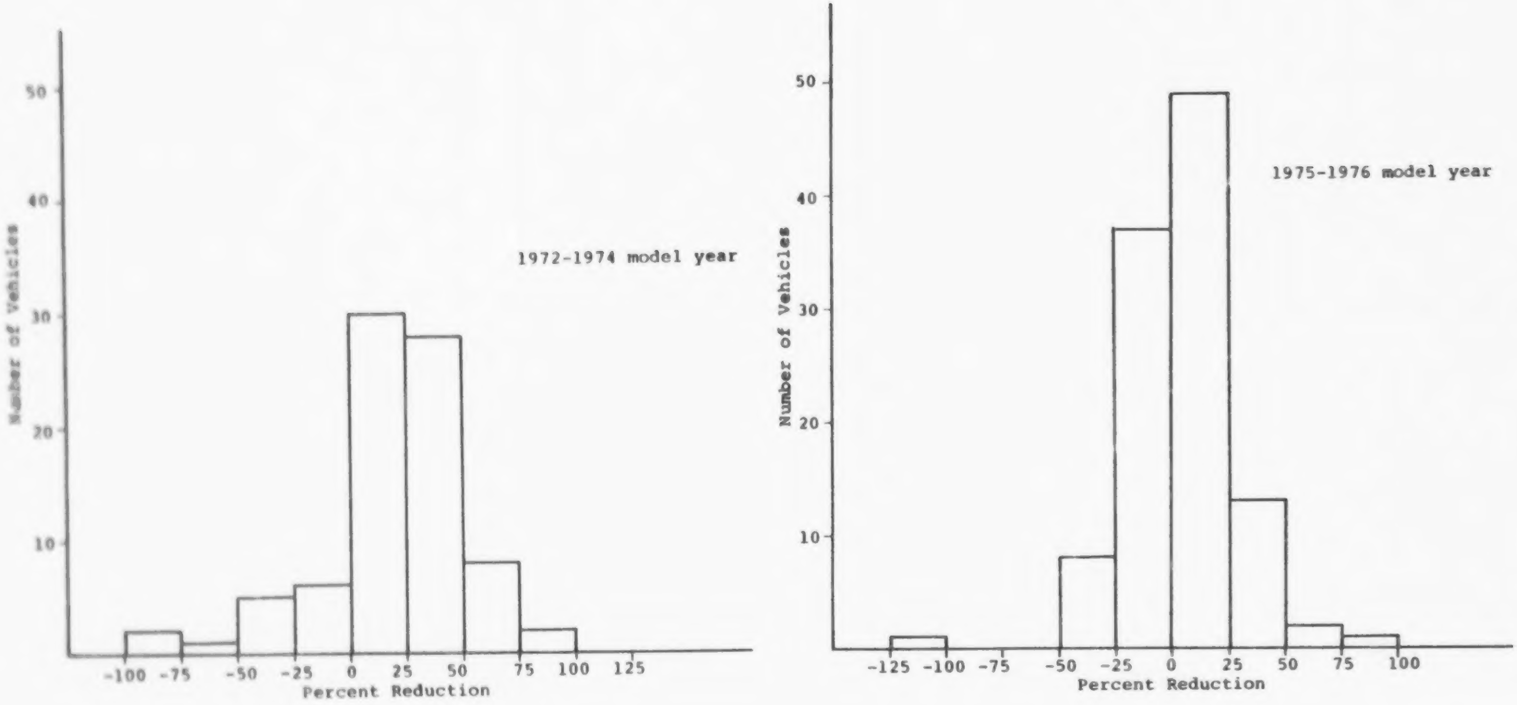


Figure 3.9. Percent Reduction in 1975 FTP NOX Emissions Due to Maintenance - All Phase I

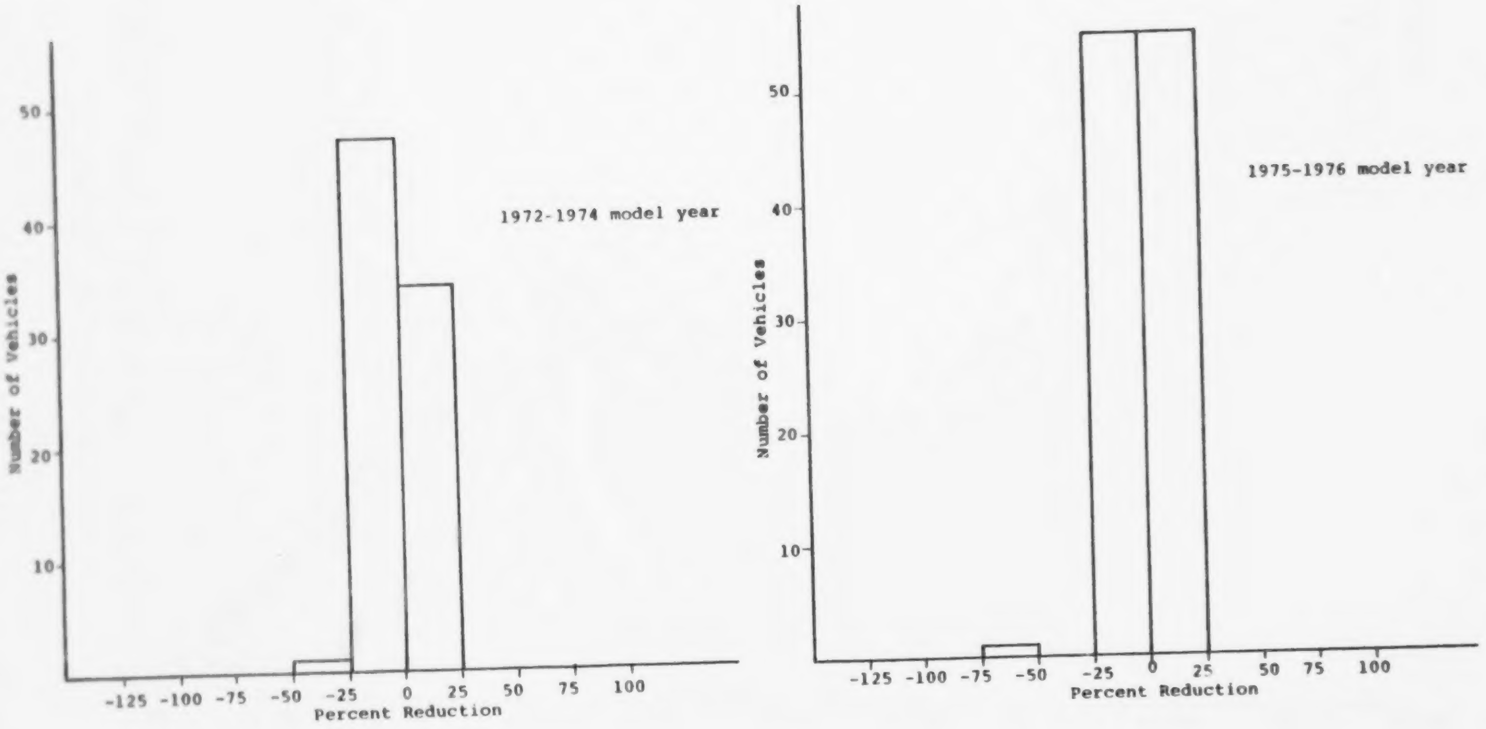


Figure 3.10. Percent Reduction in Fuel Economy due to Maintenance - All Phase I

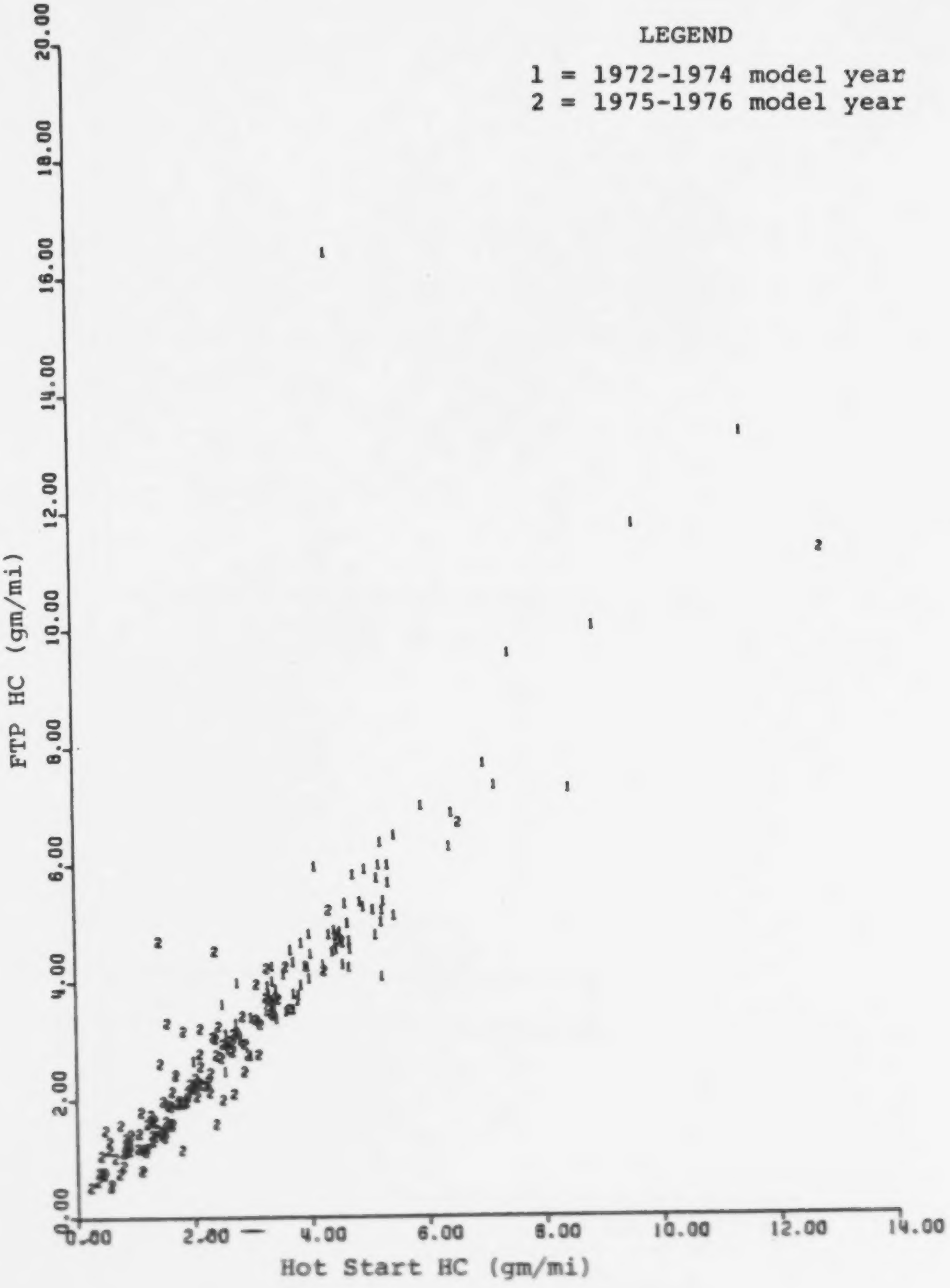


Figure 3.11. 1975 FTP HC versus Hot Start HC -- Before Maintenance, All Phase I Vehicles.

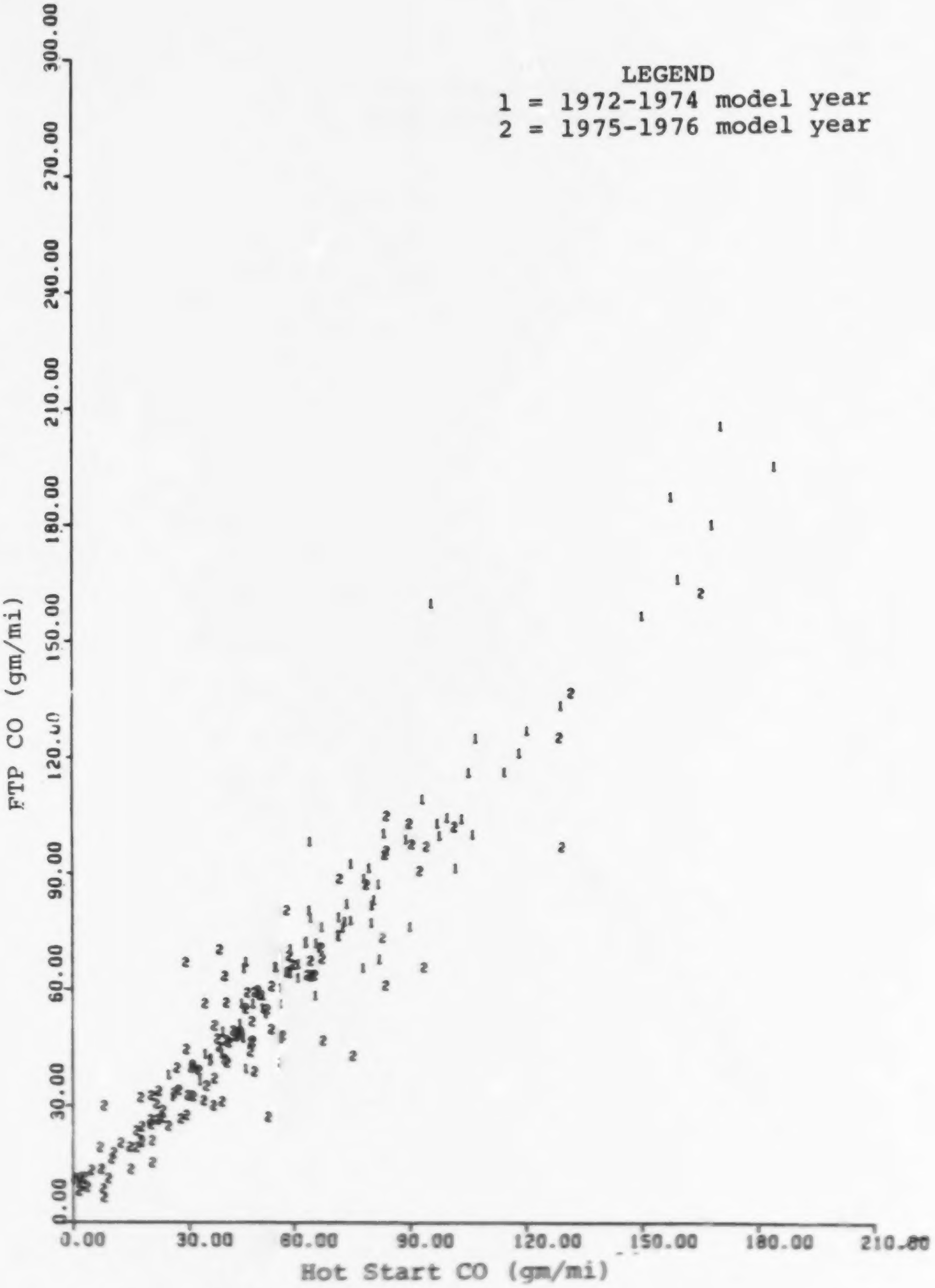


Figure 3.12 1975 FTP CO versus Hot Start CO -- Before Maintenance, All Phase I Vehicles.

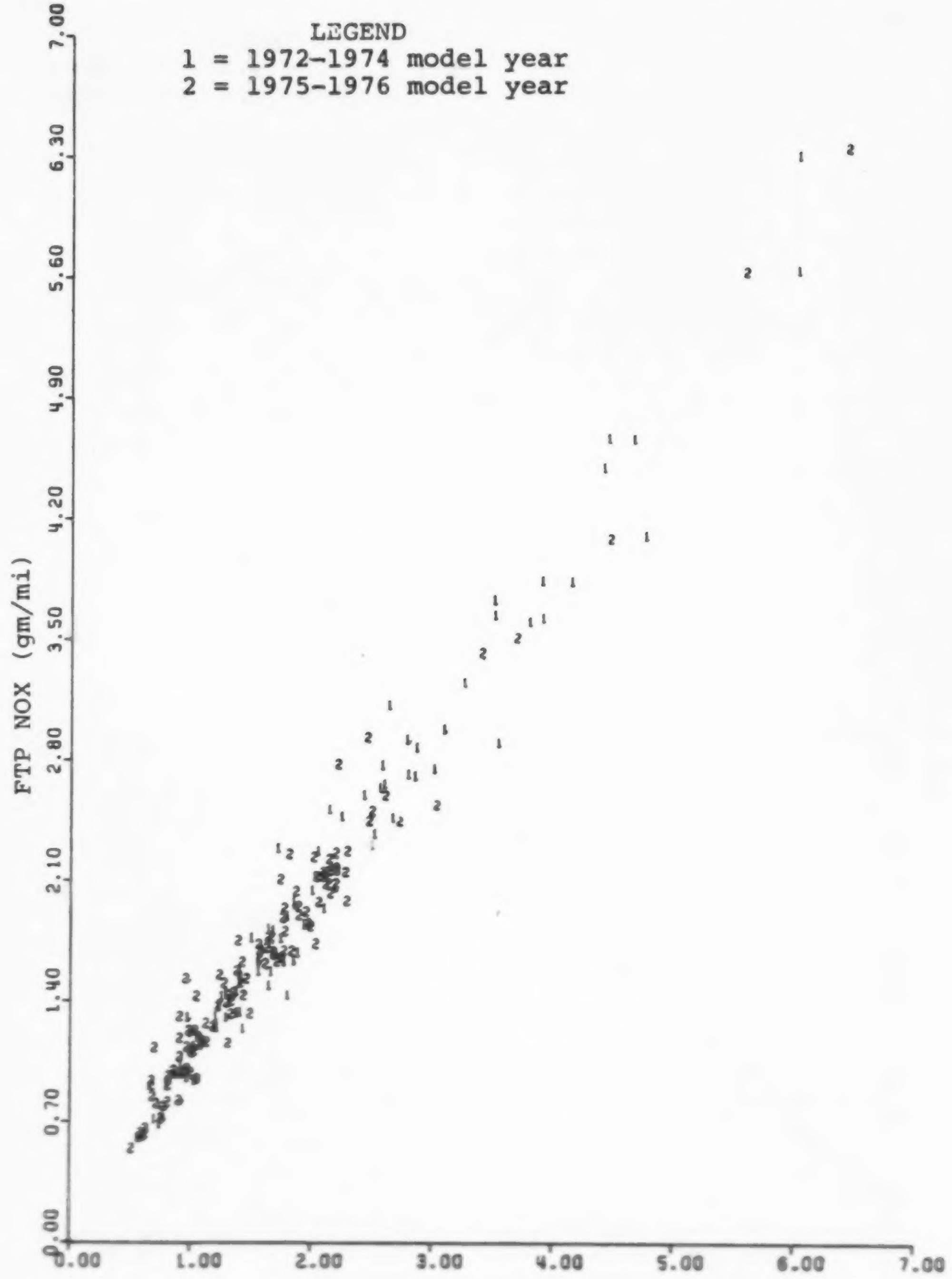


Figure 3.13. 1975 FTP NOX versus Hot Start NOX - Before Maintenance, All Phase I Vehicles.

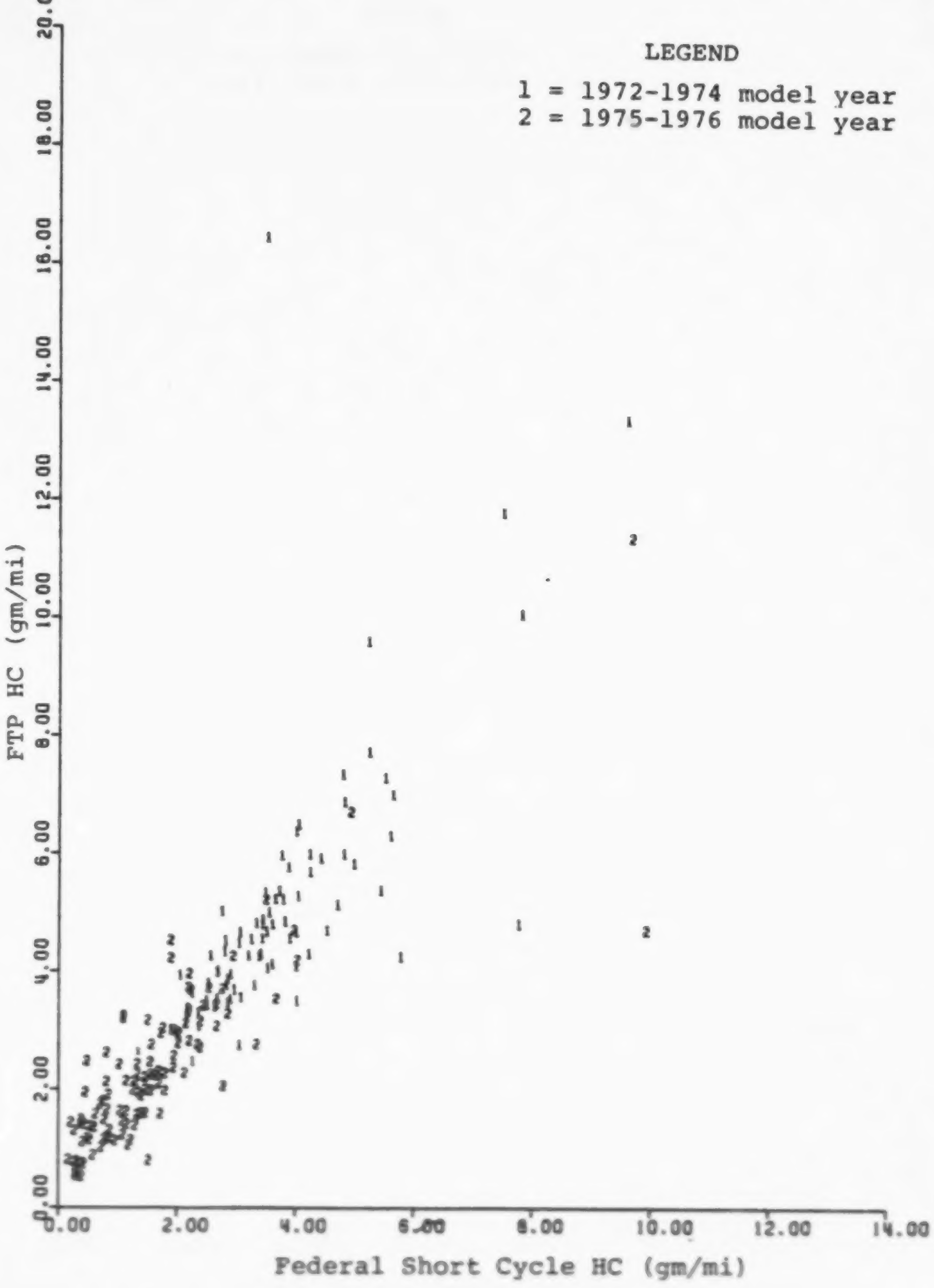


Figure 3.14. 1975 FTP HC versus Federal Short Cycle HC - Before Maintenance, All Phase I Vehicles.

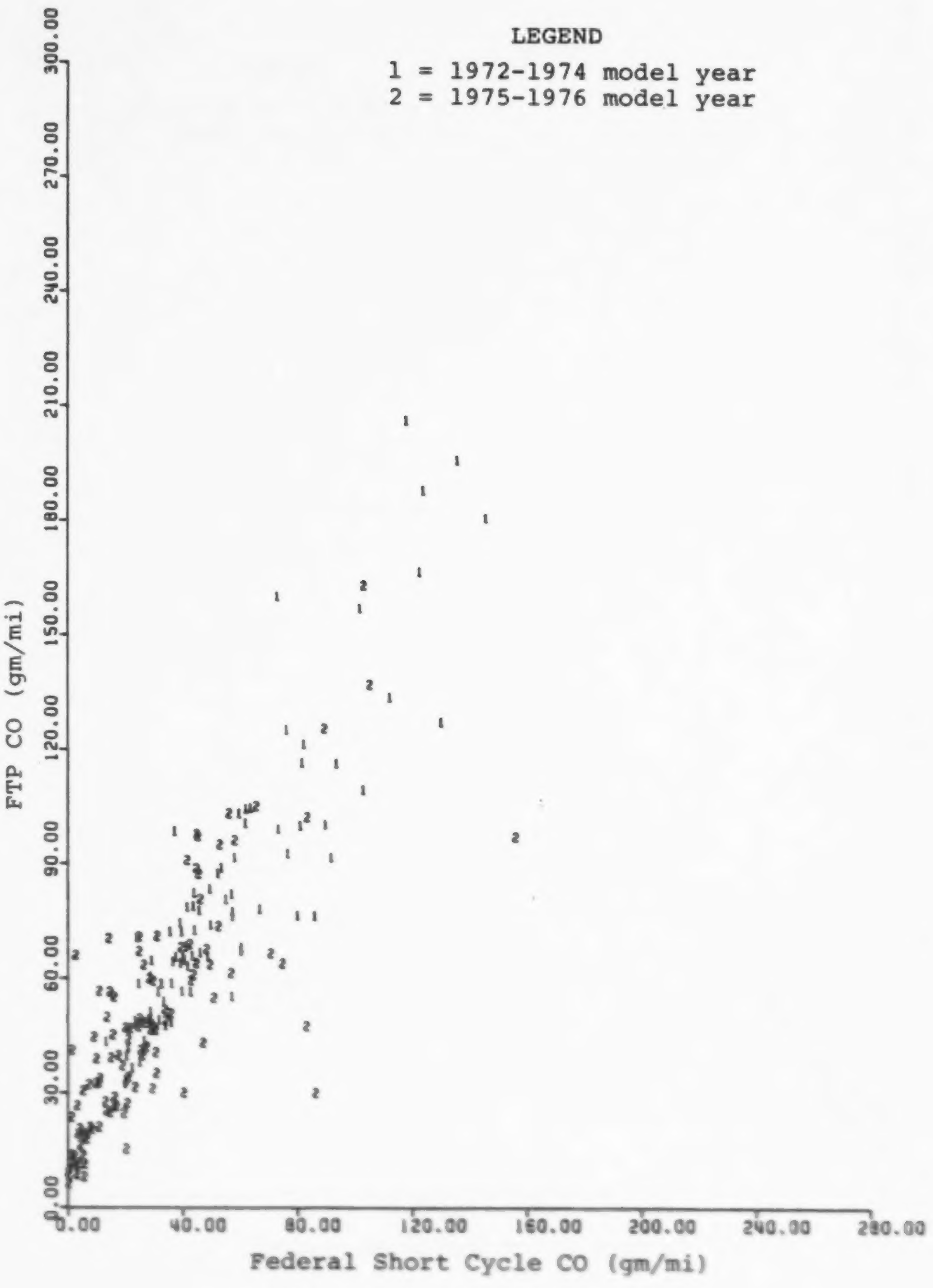


Figure 3.15. 1975 FTP CO versus Federal Short Cycle CO - Before Maintenance, All Phase I Vehicles.

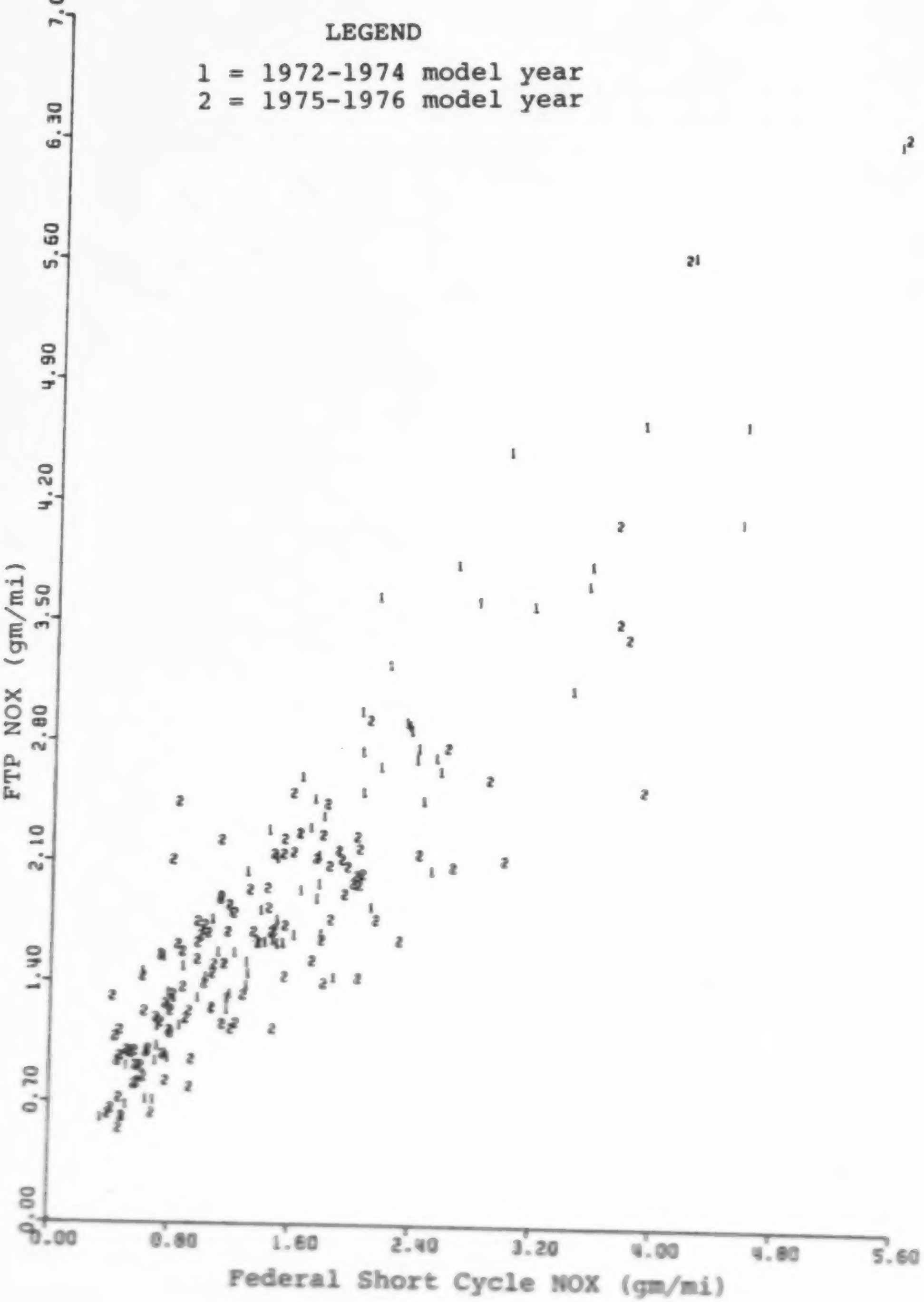


Figure 3.16. 1975 FTP NOX versus Federal Short Cycle NOX - Before Maintenance, All Phase I Vehicles.

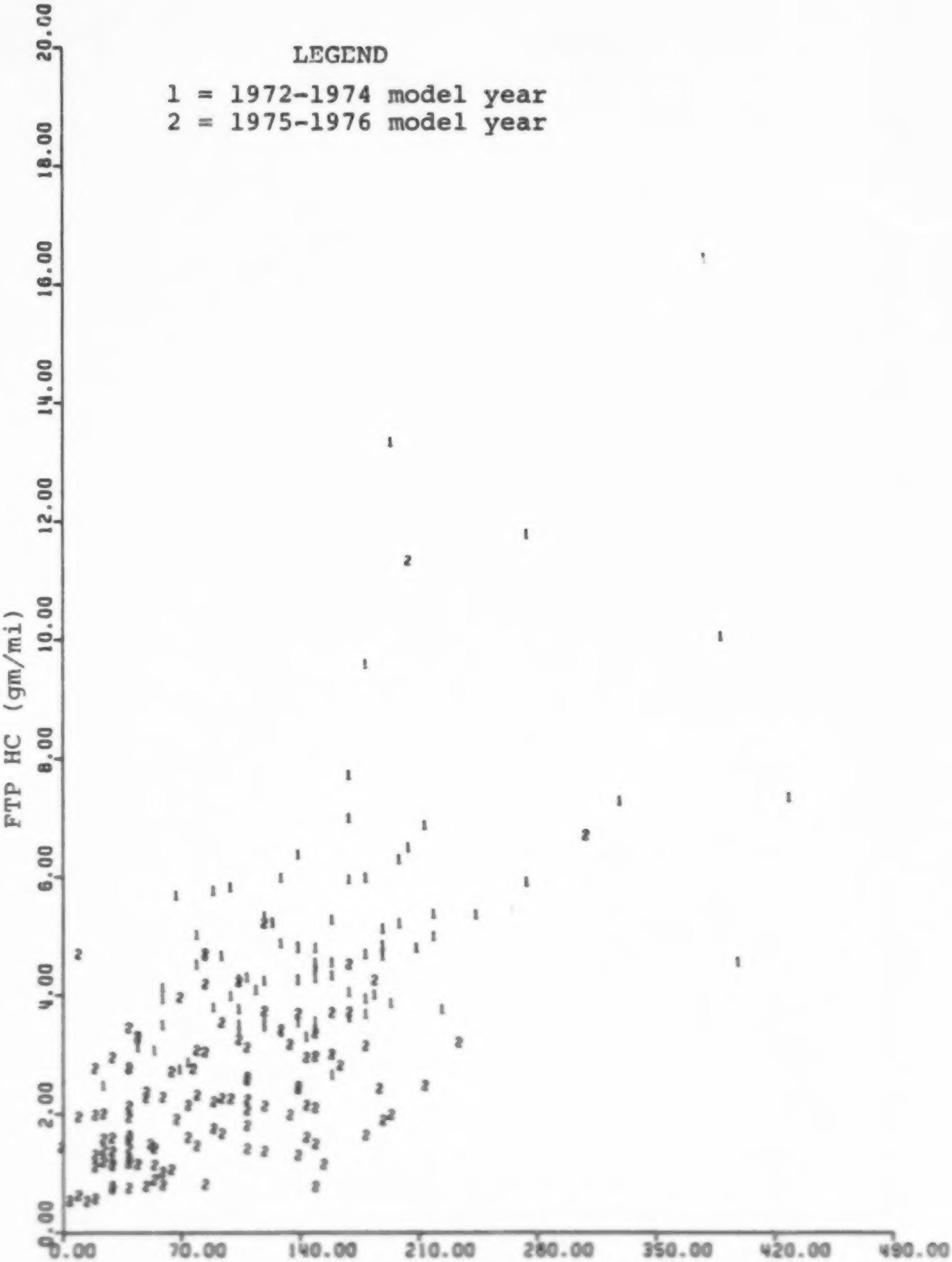


Figure 3.17. 1975 FTP HC versus Federal Three Mode (50 mph) HC - Before Maintenance, All Phase I Vehicles.

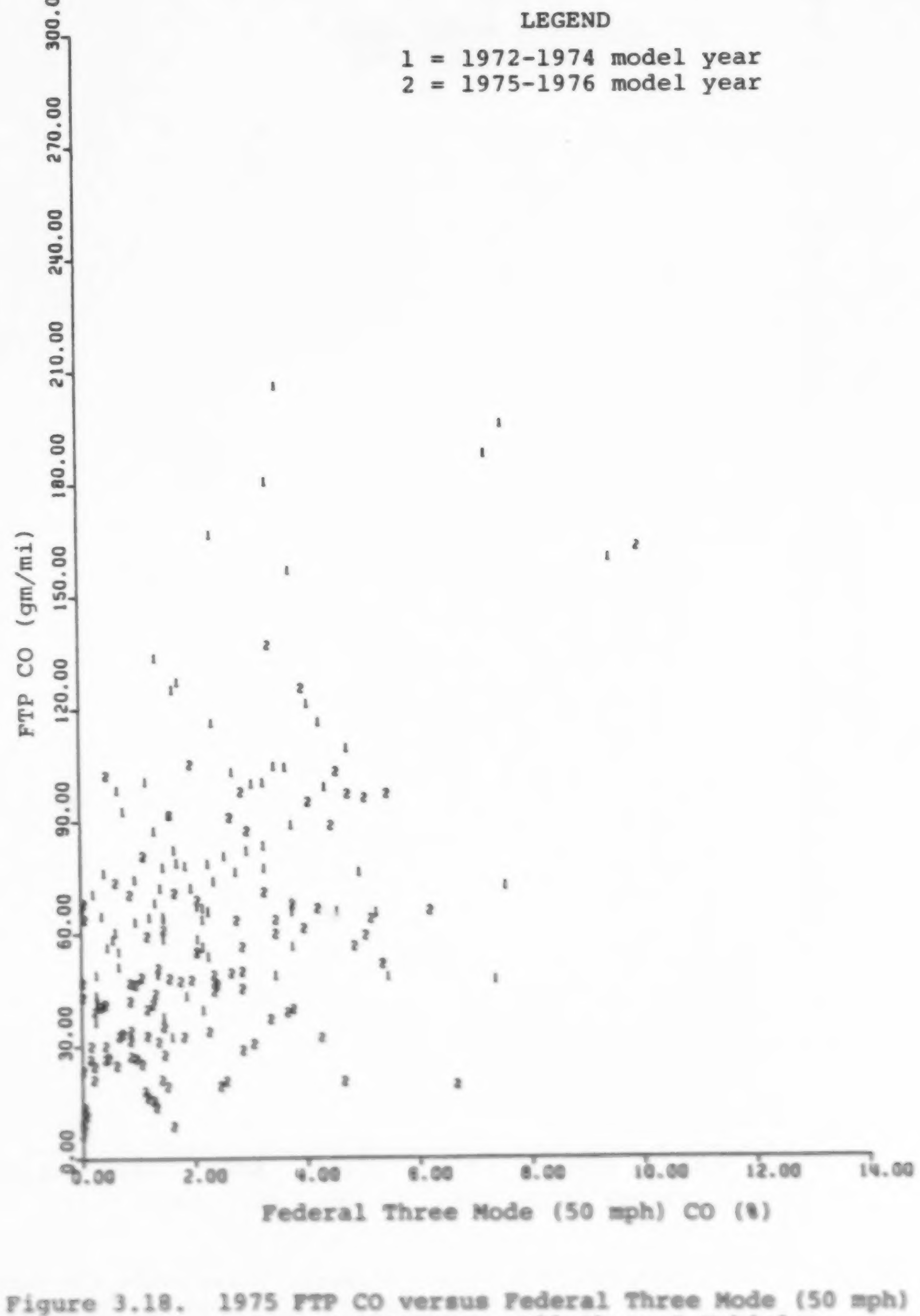


Figure 3.18. 1975 FTP CO versus Federal Three Mode (50 mph) CO - Before Maintenance, All Phase I Vehicles.

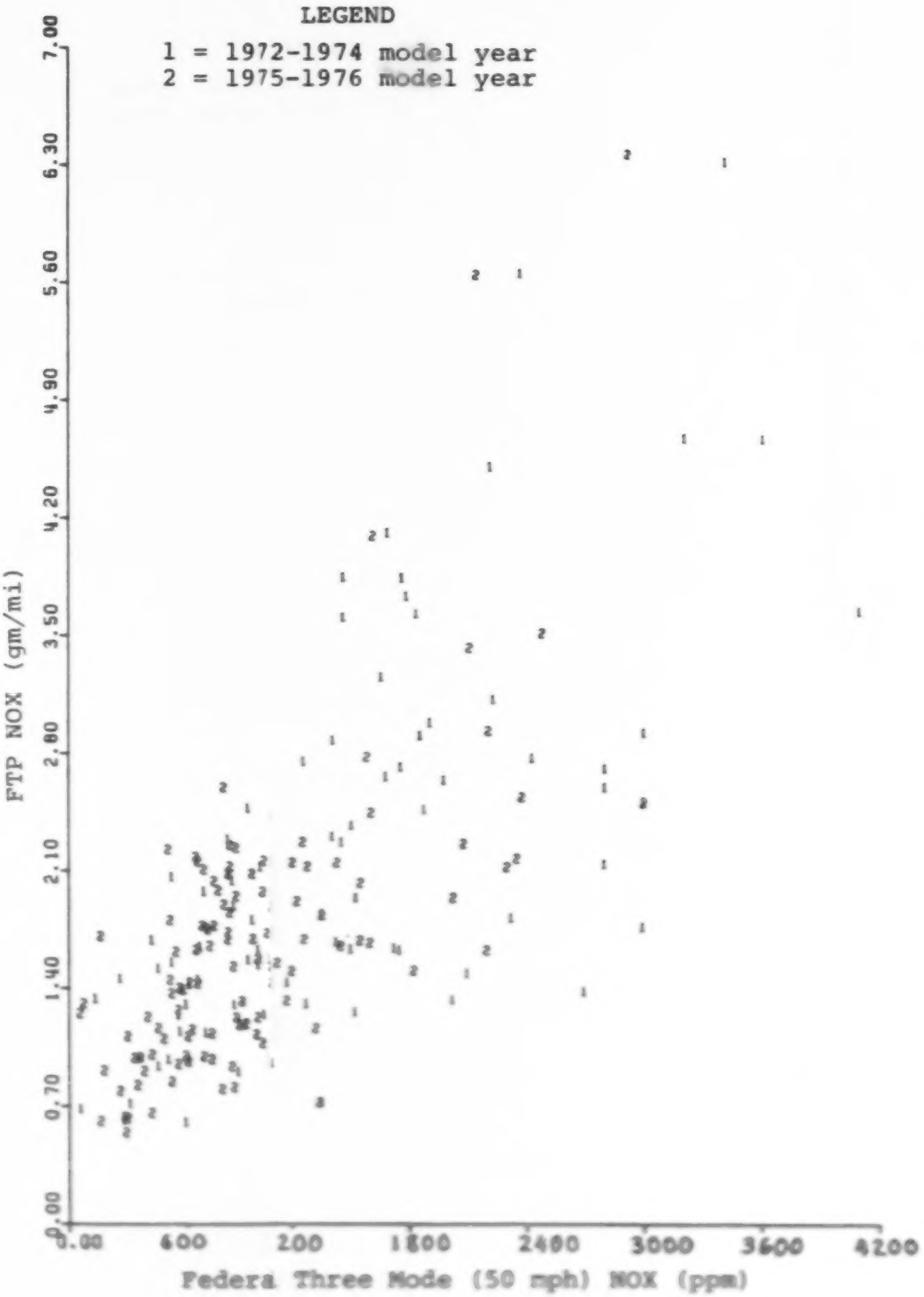


Figure 3.19. 1975 TP NOX versus Federal Three Mode (50 mph) NOX -Before Maintenance, All Phase I Vehicles.

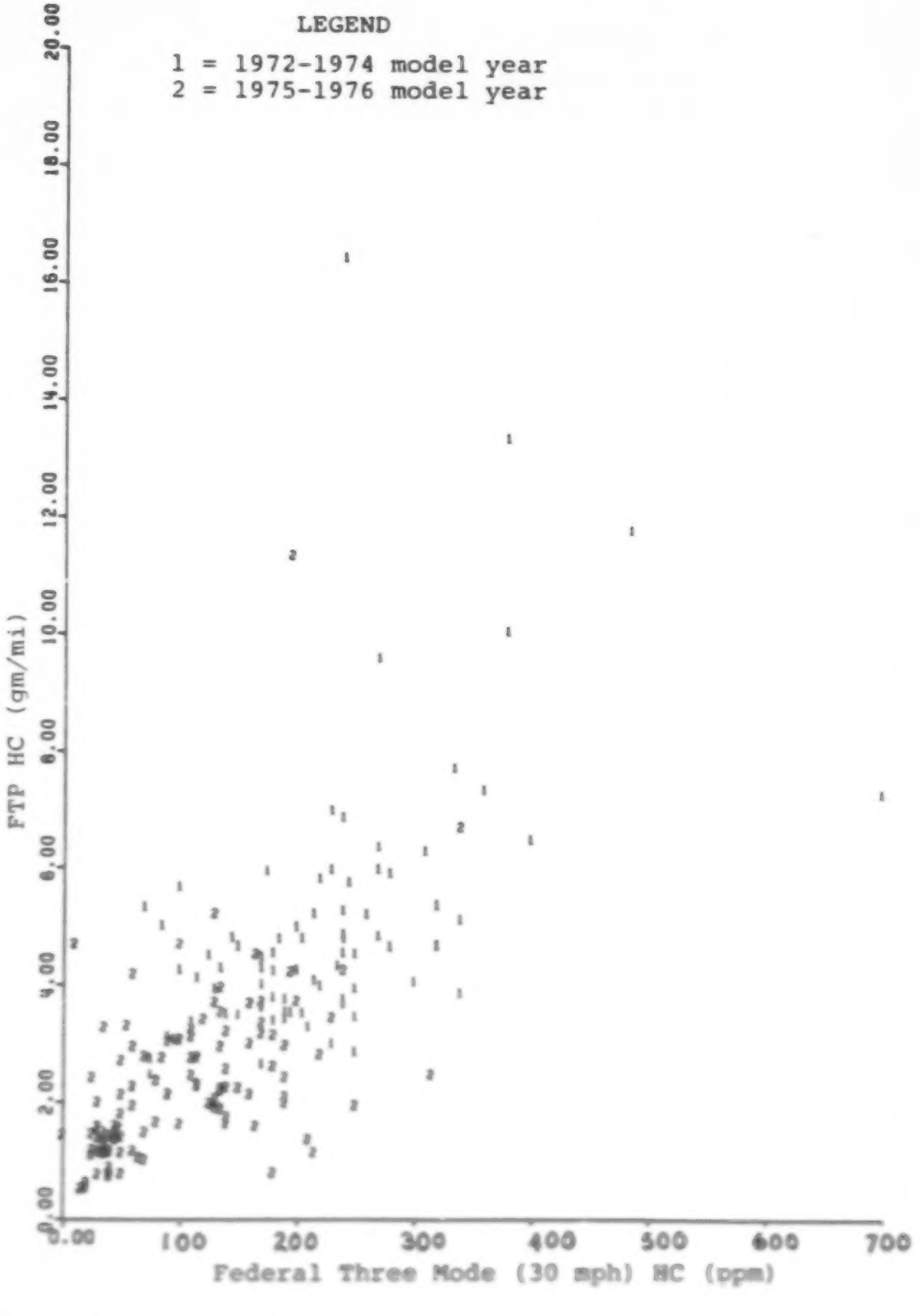


Figure 3.20. 1975 FTP HC versus Federal Three Mode (30 mph) HC - Before Maintenance, All Phase I Vehicles.

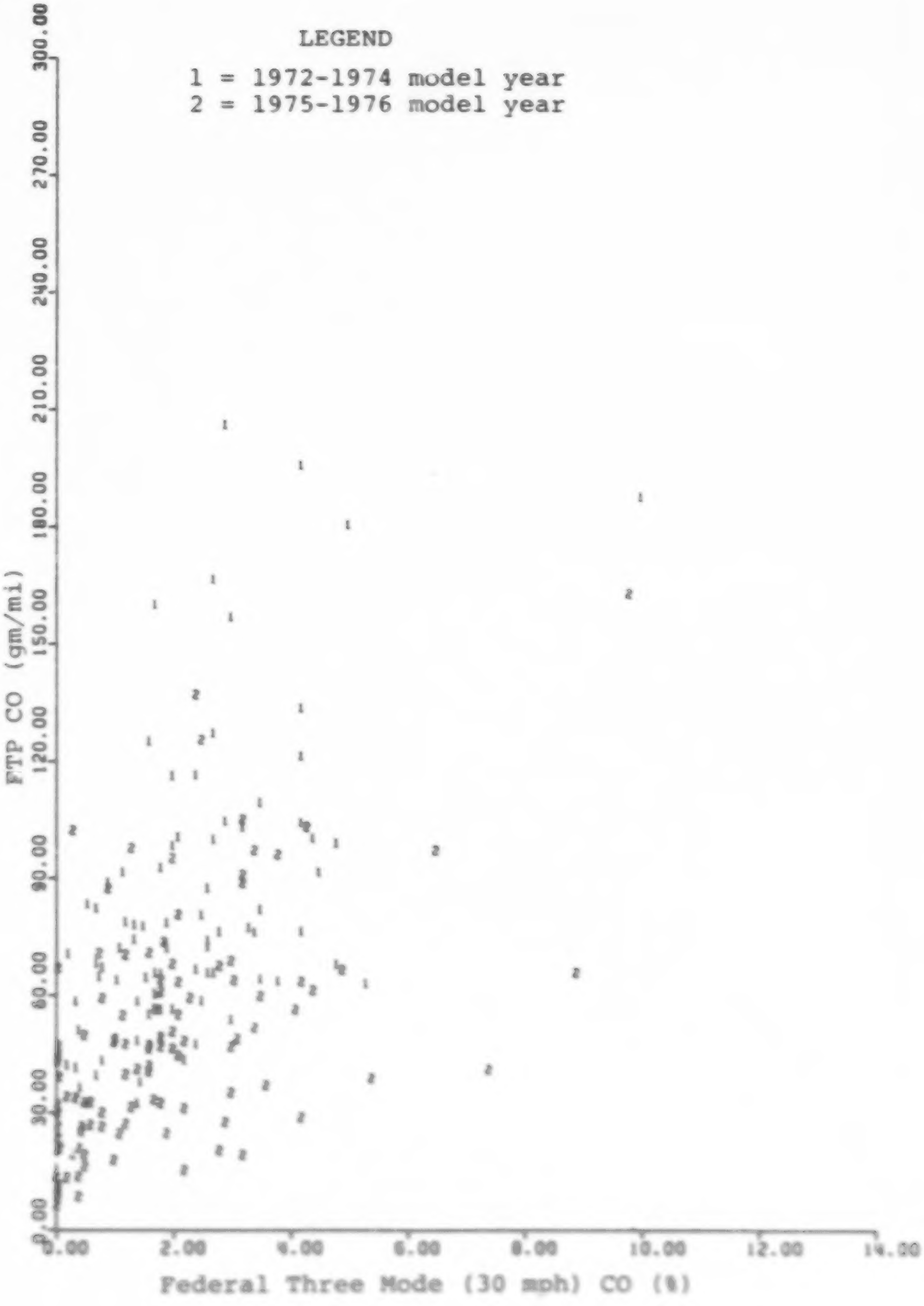


Figure 3.21. 1975 FTP CO versus Federal Three Mode (30 mph) CO - Before Maintenance, All Phase I Vehicles.

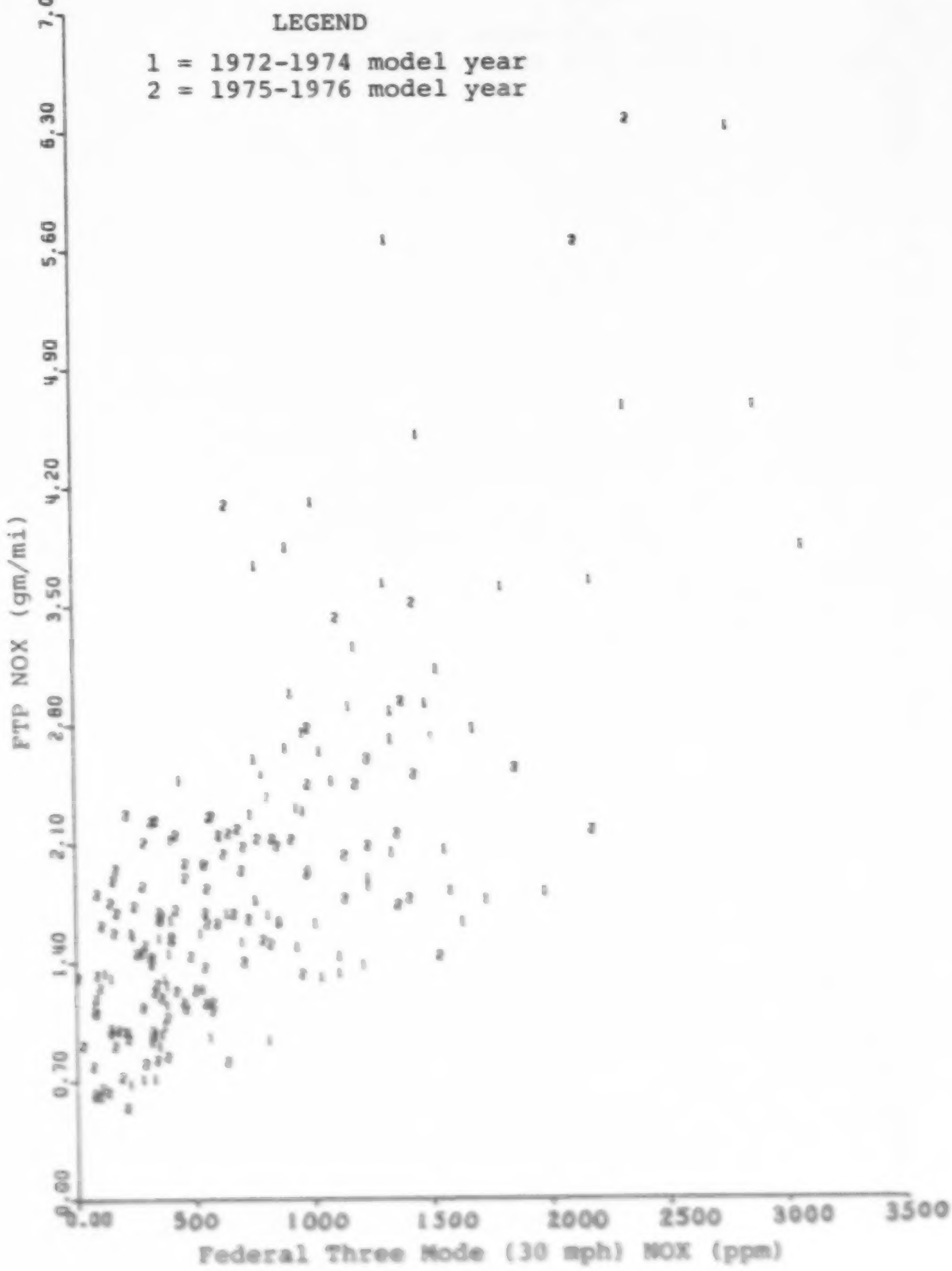


Figure 3.22. 1975 FTP NOX versus Federal Three Mode (30 mph) NOX - Before Maintenance, All Phase I Vehicles.

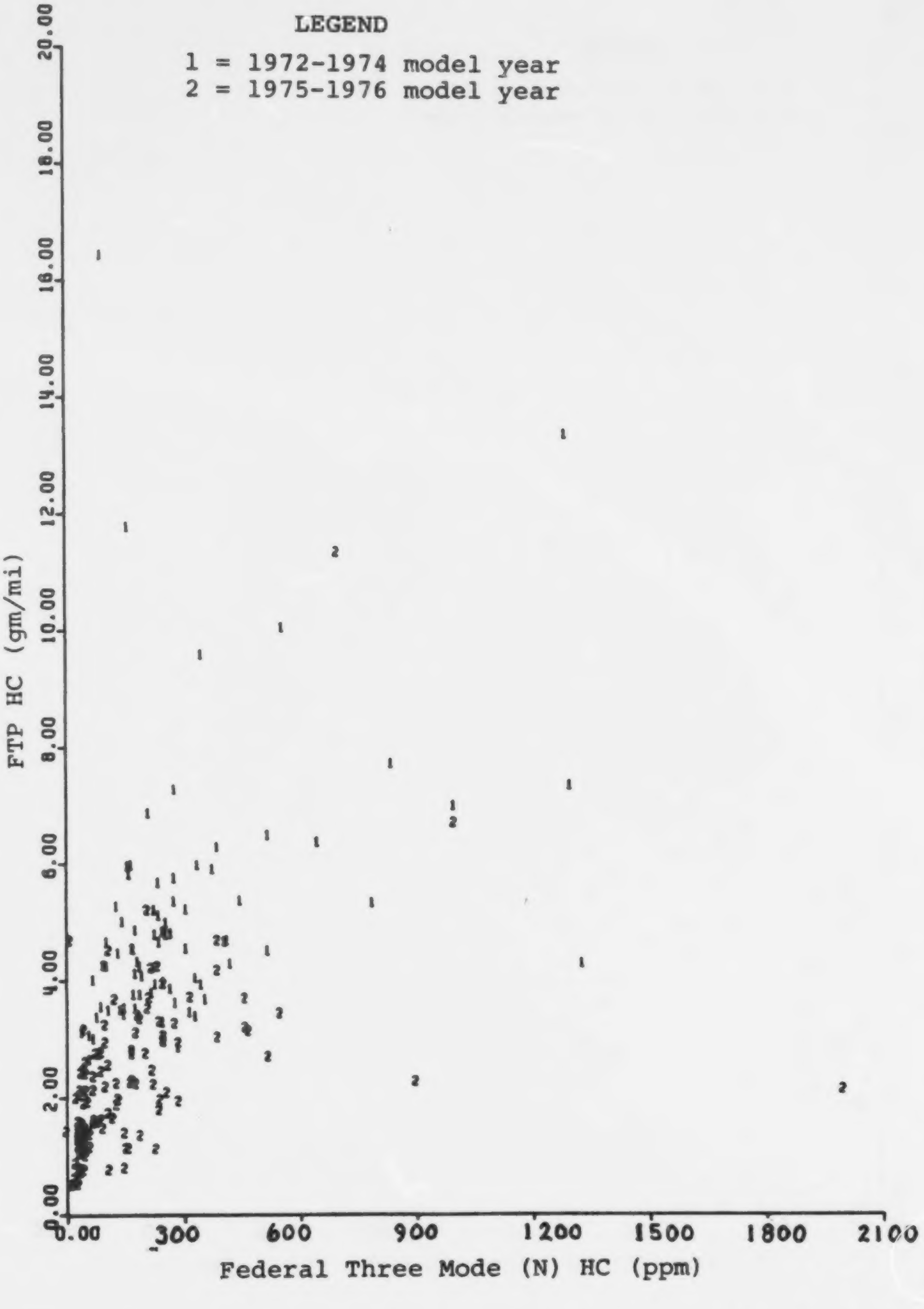


Figure 3.23. 1975 FTP HC versus Federal Three Mode (N) HC - Before Maintenance, All Phase I Vehicles.

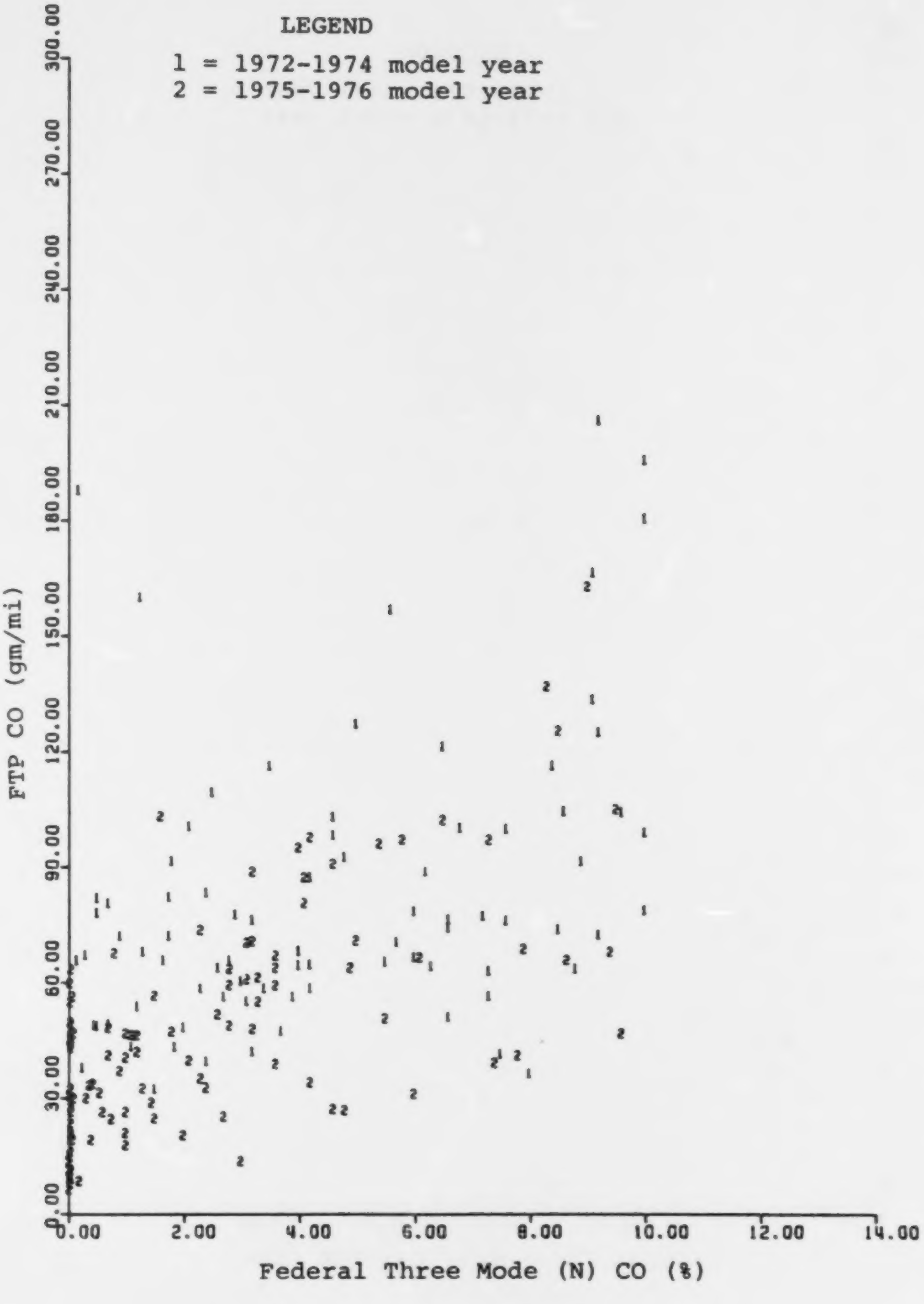


Figure 3.24. 1975 FTP CO versus Federal Three Mode (N) CO - Before Maintenance, All Phase I Vehicles.

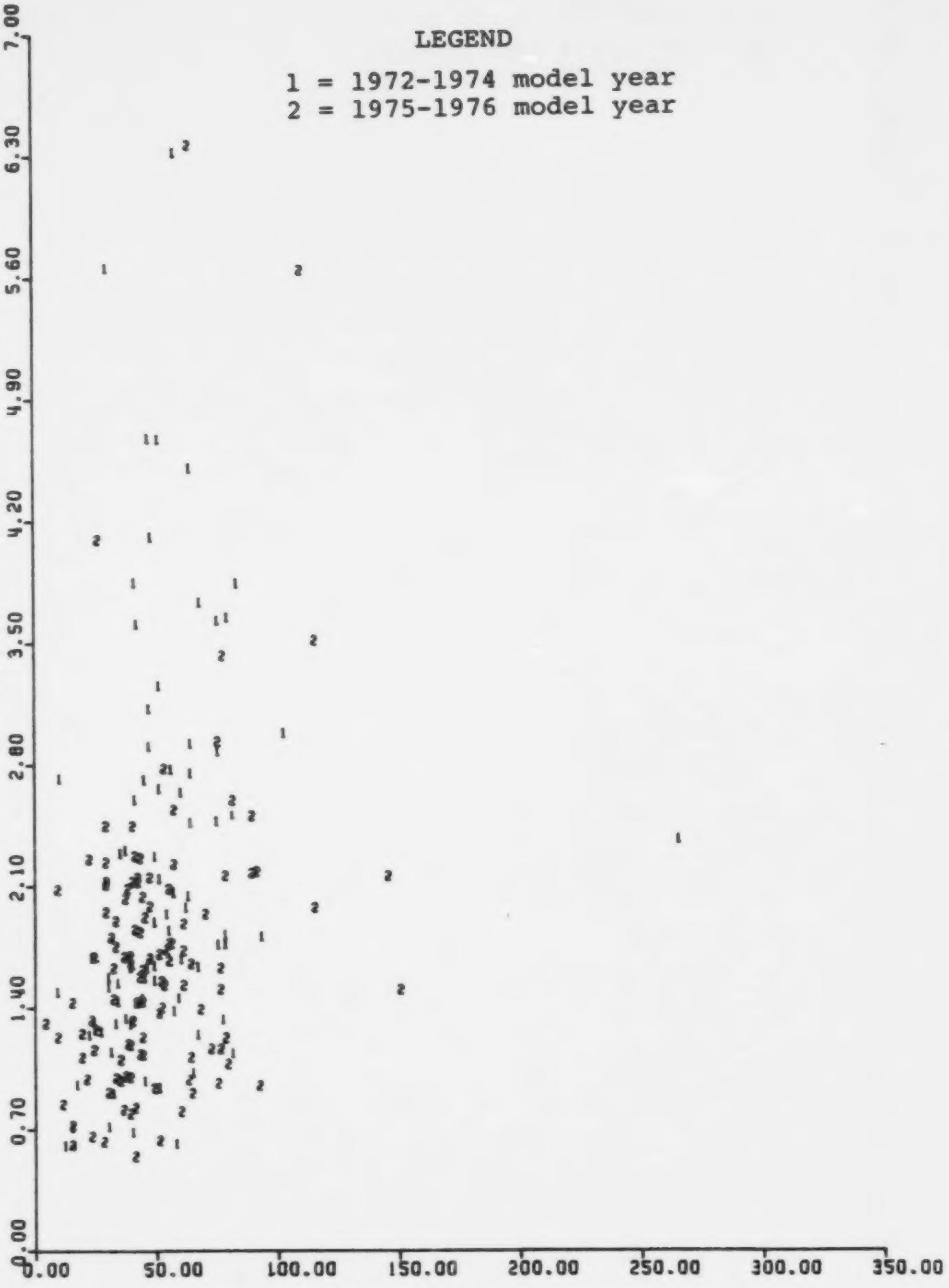


Figure 3.25. 1975 FTP NOX versus Federal Three Mode (N) NOX - Before Maintenance, All Phase I Vehicles.

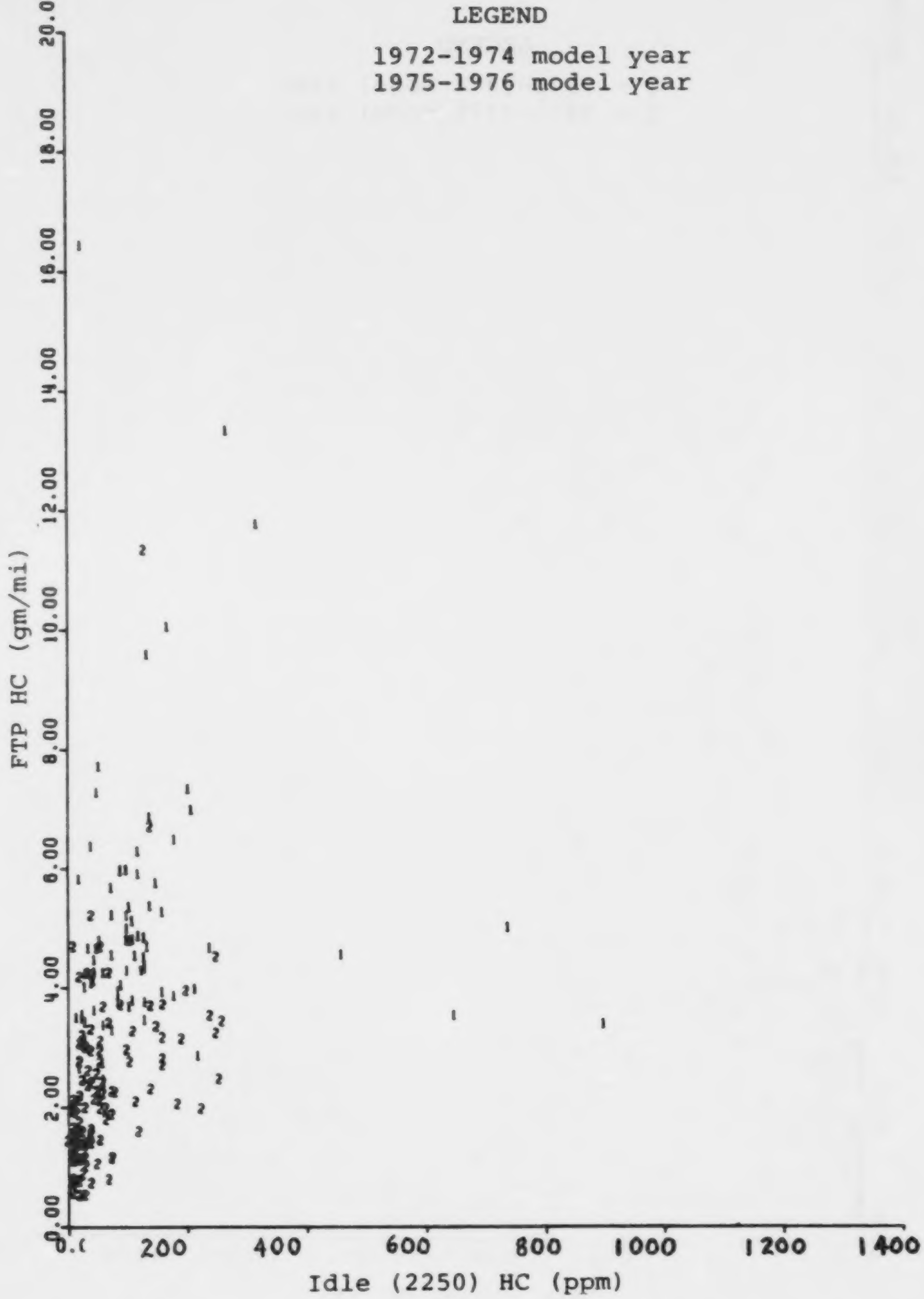


Figure 3.26. 1975 FTP HC versus Idle (2250) HC - Before Maintenance, All Phase I Vehicles.

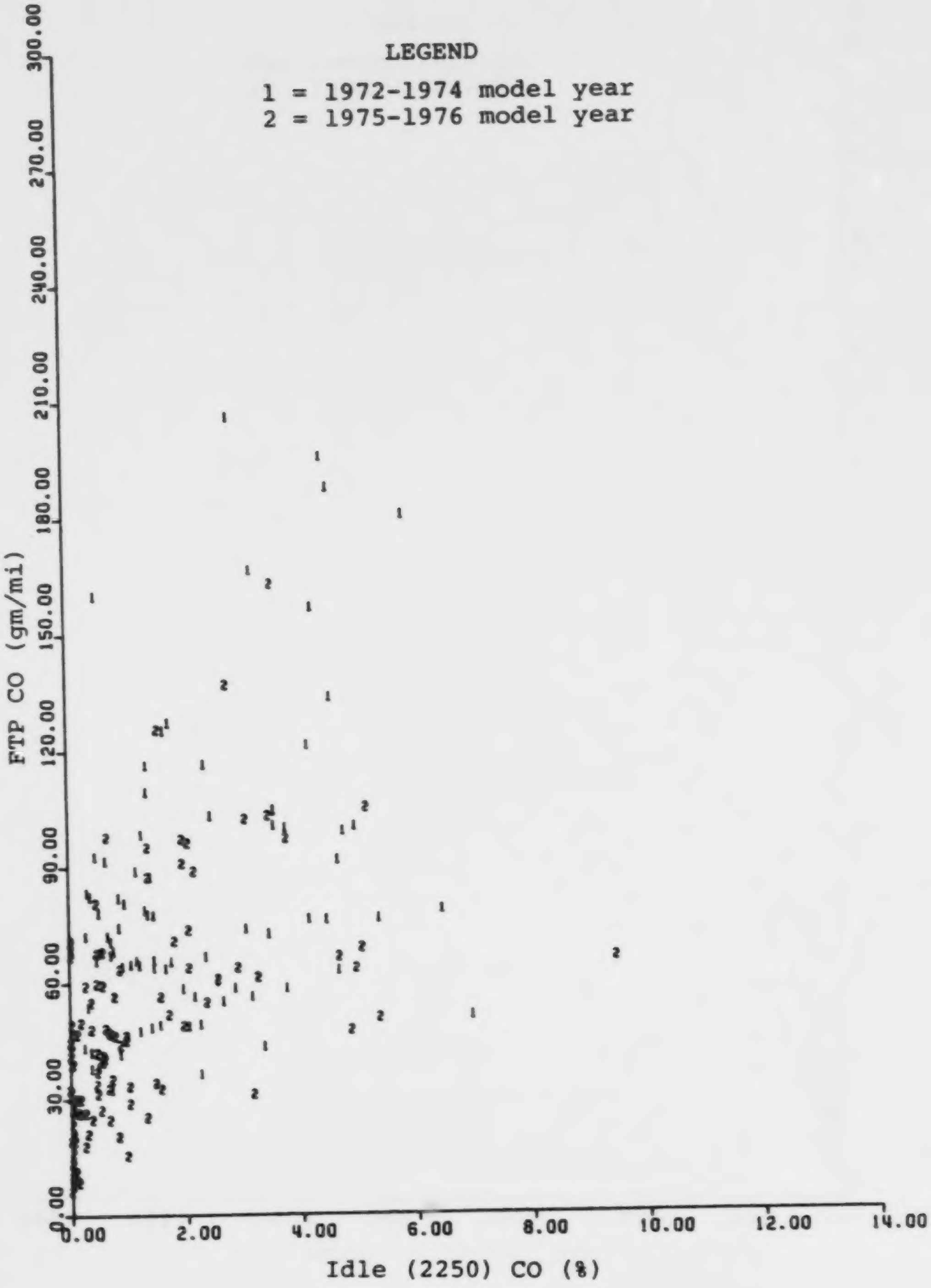


Figure 3.27. 1975 FTP CO versus Idle (2250) CO - Before Maintenance, All Phase I Vehicles.

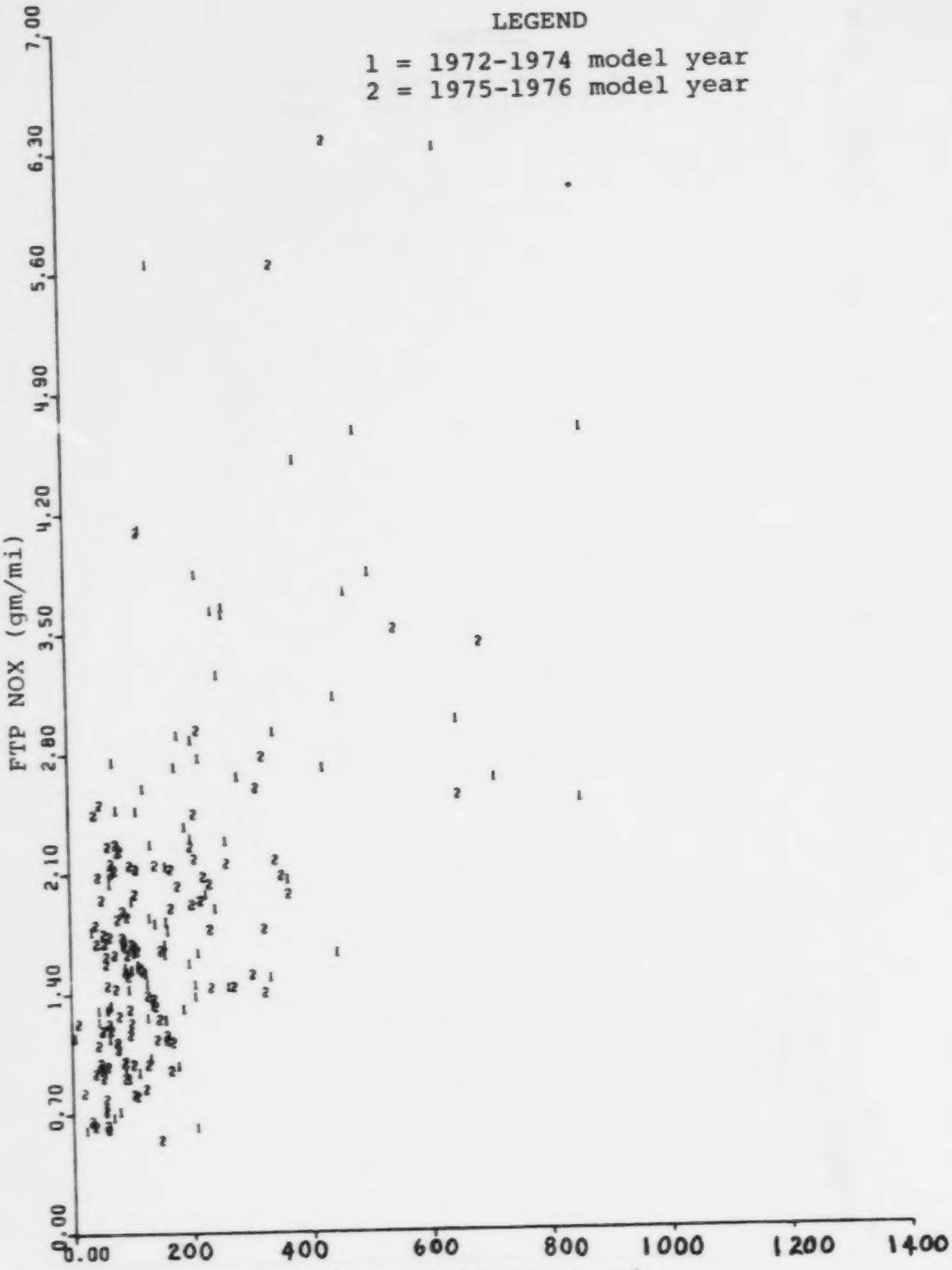


Figure 3.28. 1975 FTP NOX versus Idle (2250) NOX - Before Maintenance, All Phase I Vehicles.

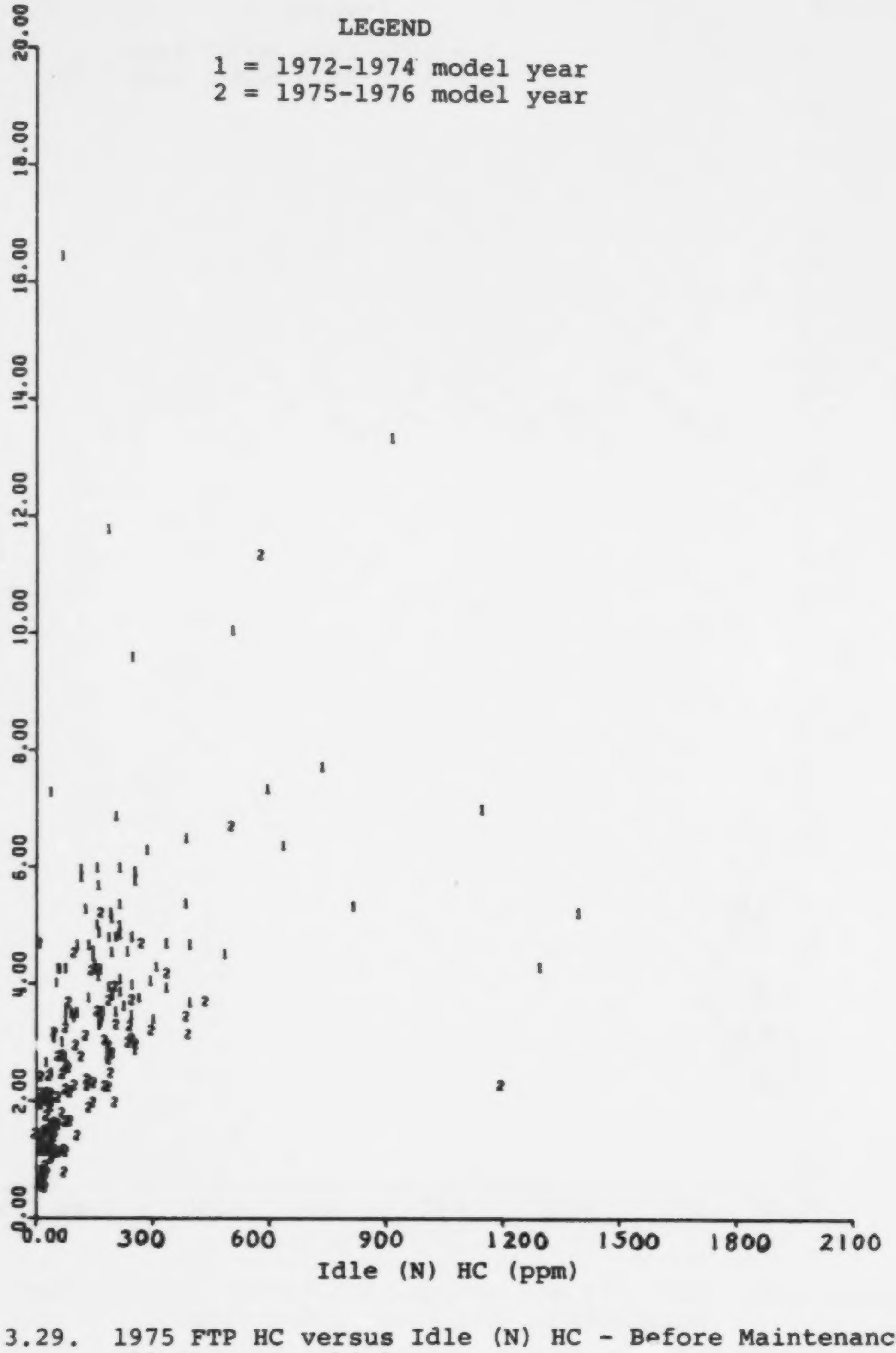


Figure 3.29. 1975 FTP HC versus Idle (N) HC - Before Maintenance, All Phase I Vehicles.

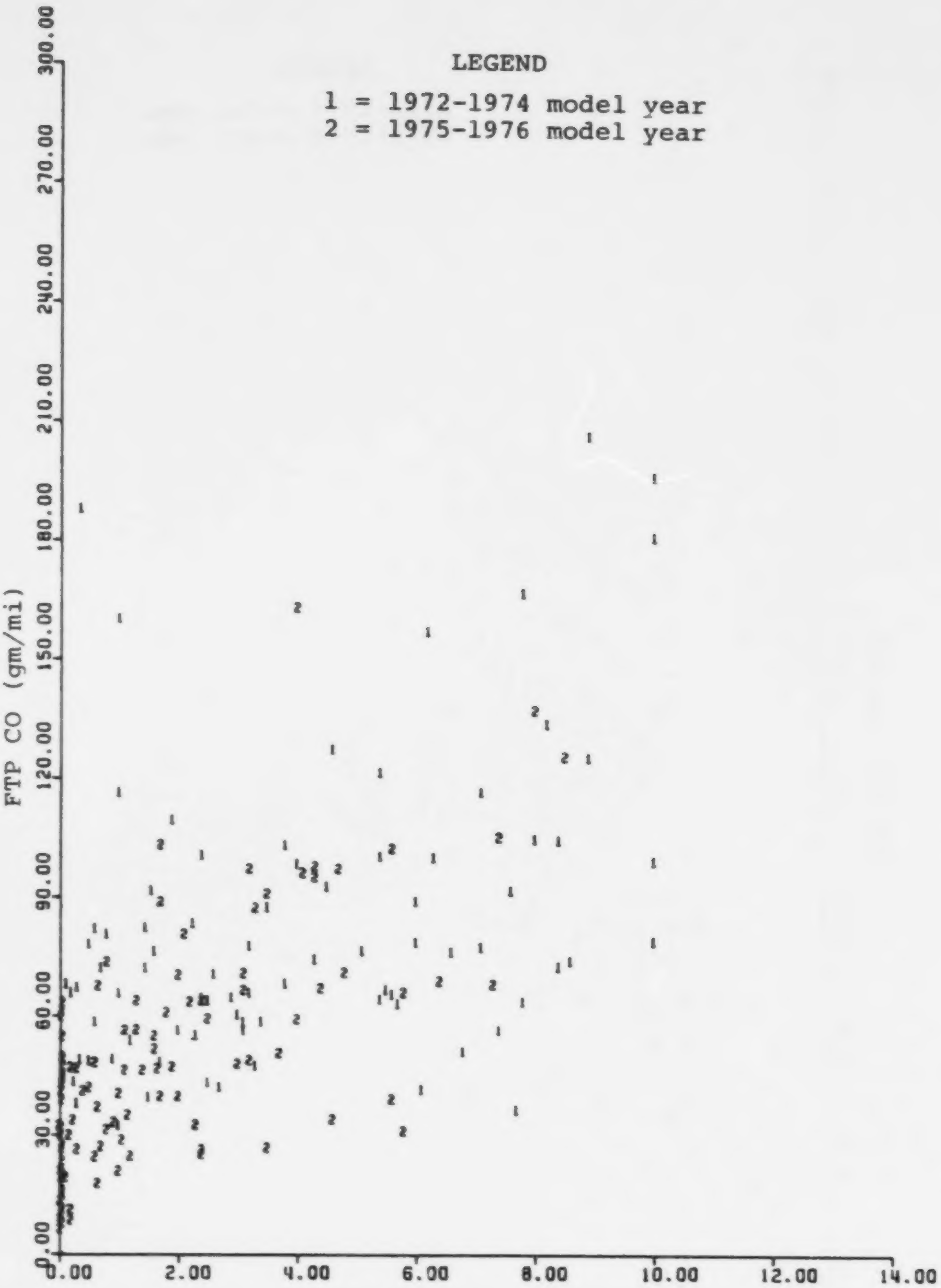


Figure 3.30. 1975 FTP CO versus Idle (N) CO - Before Maintenance, All Phase I Vehicles.

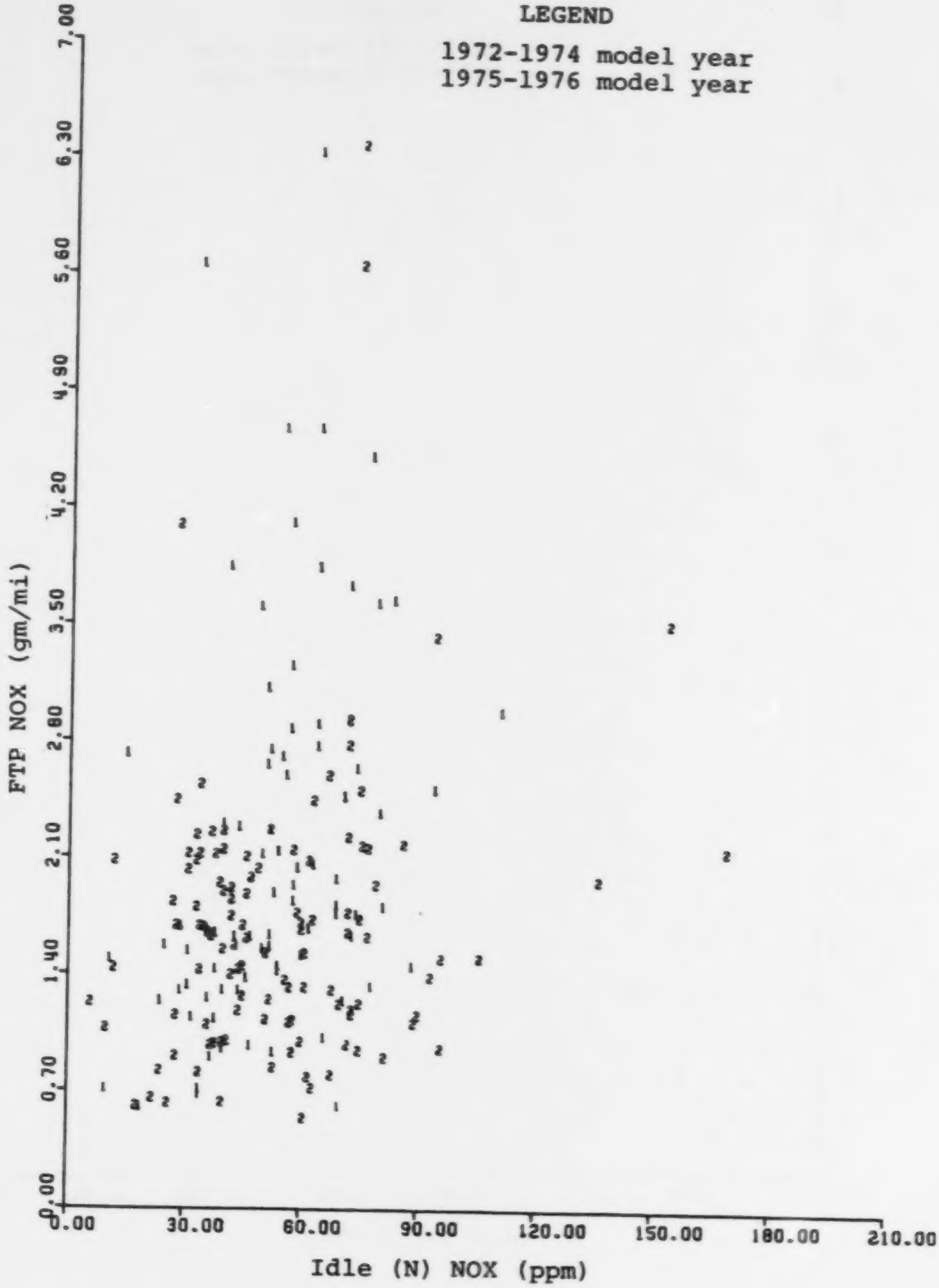


Figure 3.31. 1975 FTP NOX versus Idle (N) NOX - Before Maintenance, All Phase I Vehicles.

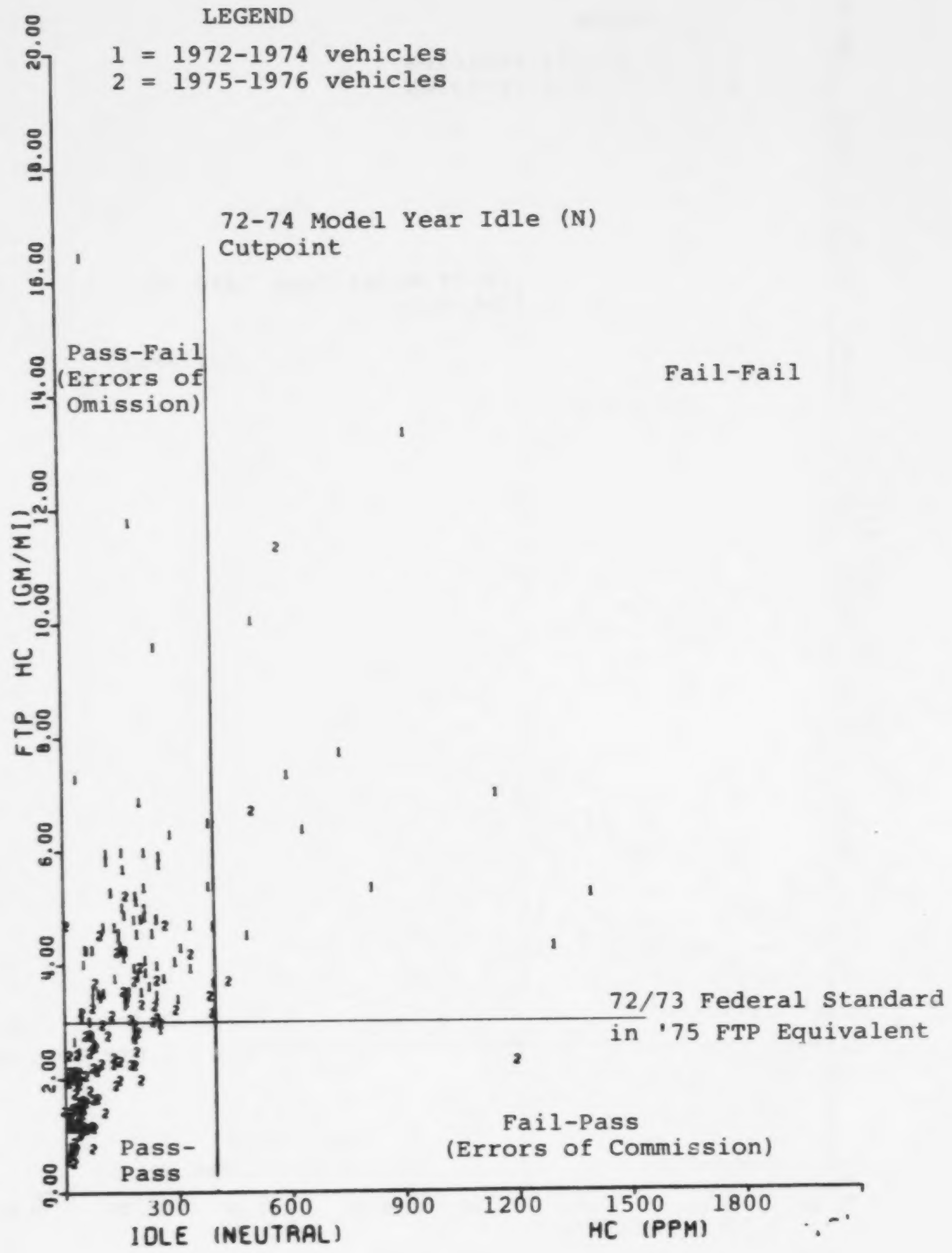


Figure 3.32. 1975 FTP HC versus Idle (N) HC - Before Maintenance, All Phase I Vehicles.

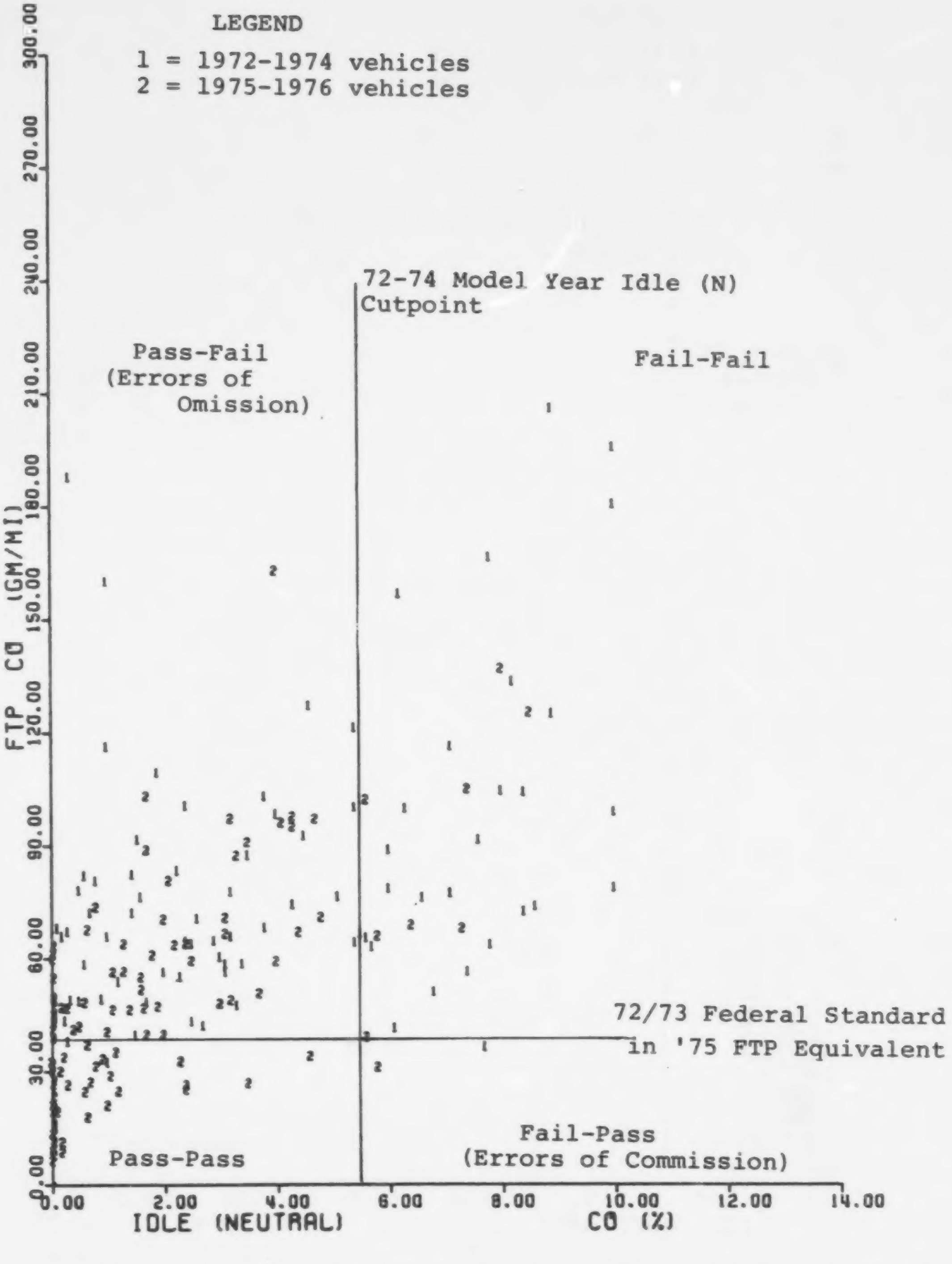


Figure 3.33. 1975 FTP CO versus Idle (N) CO - Before Maintenance, All Phase I Vehicles.

TABLE 3.1

NUMBER OF TEST VEHICLES BY MODEL YEAR, PHASE, AND PASS/FAIL STATUS

	Phase I		Phase II	
Model Year	Pass	Fail	Pass	Fail
1972	14	11	47	39
1973	16	11	52	42
1974	22	8	47	23
1972-1974	52	30	146	104
1975-1976	72	39	135	85
Total	124	69	281	189

Population I	All Phase I	193 vehicles
Population II	All Passing Phase I	124 vehicles
Population III	All Failing Phases I and II	258 vehicles

TABLE 3.2

AVERAGE 1975 FTP EMISSIONS AND FUEL ECONOMY BEFORE AND AFTER MAINTENANCE

			HC			CO			NOX			F.E.		
	Model Year	N	Before	After	% Reduction	Before	After	% Reduction	Before	After	% Reduction	Before	After	% Reduction
All Phase I	72	25	6.53	4.16	36	84.47	59.07	30	2.68	2.61	3*	14.20	14.26	0*
	73	27	4.60	4.01	13	80.99	58.59	28	2.06	2.11	-2*	13.70	14.00	-2*
	74	30	5.15	4.12	20	83.67	59.13	29	1.85	1.87	-1*	13.63	13.88	-2*
	72-74	82	5.39	4.10	24	83.03	58.94	29	2.17	2.17	0*	13.82	14.04	-2*
	75-76	111	2.31	1.69	27	50.25	35.75	29	1.72	1.59	8*	14.31	14.30	0*
Passing Phase I	72	14	4.42	4.18	5*	68.66	62.63	9*	2.96	2.82	5*	13.90	13.45	3*
	73	16	3.95	3.81	4*	70.82	55.62	21	2.04	2.15	-5*	12.50	12.61	-1*
	74	22	5.44	4.24	22	81.36	58.28	28	1.88	1.94	-3*	13.20	13.46	-2*
	72-74	52	4.71	4.09	13	74.20	58.64	21	2.22	2.24	-1*	13.15	13.18	0*
	75-76	72	1.72	1.43	17	36.53	30.80	16	1.75	1.63	7*	14.41	14.32	1*
Failing Phases I and II	72	49	7.01	5.06	28	92.35	60.60	34	2.40	2.36	2*	15.11	15.39	-2*
	73	53	6.25	4.98	20	95.52	65.15	32	1.76	1.74	1*	14.42	14.77	-2*
	74	31	5.83	4.62	21	89.26	63.18	29	1.82	1.64	10*	14.80	14.92	-1*
	72-74	133	6.44	4.92	24	92.89	62.99	32	2.01	1.95	3*	14.76	15.03	-2*
	75-76	124	3.54	2.08	41	78.35	47.04	40	1.52	1.31	14	13.84	13.79	0*

* Not a significant reduction at 95% level of confidence

TABLE 3.3

STANDARD DEVIATIONS OF 1975 FTP EMISSIONS AND FUEL ECONOMY BEFORE AND AFTER MAINTENANCE

	Model Year	N	HC		CO		NOX		F.E.	
			Before	After	Before	After	Before	After	Before	After
All Phase I	72	25	5.67	0.95	42.31	25.95	1.22	1.16	3.41	3.92
	73	27	1.61	1.40	32.73	20.62	1.26	1.07	3.49	3.66
	74	30	2.74	1.05	38.54	14.80	0.84	0.86	3.52	3.29
	72-74	82	3.70	1.14	37.53	20.17	1.15	1.06	3.45	3.56
	75-76	111	1.43	0.90	37.85	20.80	0.86	0.79	3.74	3.60
Passing Phase I	72	14	0.84	0.82	26.21	33.37	1.40	1.41	3.54	3.90
	73	16	0.95	1.15	19.37	15.54	1.04	1.13	2.62	2.61
	74	22	3.07	1.14	36.74	14.78	0.90	0.93	2.85	2.85
	72-74	52	2.18	1.06	29.58	21.26	1.17	1.17	2.93	3.03
	75-76	72	0.84	0.83	19.69	15.43	0.94	0.88	3.63	3.59
Failing Phases I and II	72	49	4.28	2.41	27.49	25.47	0.93	0.90	2.68	4.15
	73	53	6.40	3.32	39.67	29.78	1.00	0.78	4.00	4.21
	74	31	2.80	1.73	33.16	20.03	0.99	0.67	4.44	4.01
	72-74	133	3.64	2.67	37.24	25.21	1.01	0.86	3.99	4.13
	75-76	124	2.09	1.05	40.22	27.38	0.63	0.55	3.26	3.15

TABLE 3.4
PERCENT BENEFIT IN AN I/M PROGRAM WITH A 10 PERCENT STRINGENCY FACTOR - 1975 FTP

	HC	CO	NOX	F.E.
1972-1974				
Mean of Passed Cars	4.81	80.33	2.19	13.64
Mean of Failed Cars before Maint.	8.95	95.92	1.89	15.40
Population Mean (10% Failures)	5.22	81.89	2.16	13.82
Mean of Failed Cars after Maint.	5.83	73.66	1.76	15.40
Population Mean (10% Failure)	4.91	79.66	2.15	13.82
Percent Benefit	6	3	1	0
1975-1976				
Mean of Passed Cars	2.11	45.07	1.73	14.35
Mean of Failed Cars before Maint.	4.14	97.60	1.36	13.71
Population Mean (10% Failure)	2.31	50.32	1.69	14.29
Mean of Failed Cars after Maint.	2.18	49.49	1.23	14.01
Population Mean (10% Failure)	2.12	45.51	1.68	14.32
Percent Benefit	8	10	1	0

TABLE 3.5

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 20 PERCENT STRINGENCY FACTOR - 1975 FTP

	HC	CO	NOX	F.E.
1972-1974				
Mean of Passed Cars	4.67	76.85	2.21	13.63
Mean of Failed Cars before Maint.	7.84	97.54	1.88	15.11
Population Mean (20% Failures)	5.30	80.99	2.14	13.93
Mean of Failed Cars after Maint.	5.62	66.61	1.88	15.45
Population Mean (20% Failure)	4.86	74.80	2.14	13.99
Percent Benefit	8	8	0	0
1975-1976				
Mean of Passed Cars	1.94	40.41	1.74	14.44
Mean of Failed Cars before Maint.	3.78	89.57	1.42	13.77
Population Mean (20% Failure)	2.31	50.24	1.68	14.31
Mean of Failed Cars after Maint.	2.10	49.32	1.22	13.85
Population Mean (20% Failure)	1.97	42.19	1.64	14.32
Percent Benefit	14	16	2	0

TABLE 3.6
PERCENT BENEFIT IN AN I/M PROGRAM WITH A 30 PERCENT STRINGENCY FACTOR - 1975 FTP

	HC	CO	NOX	F.E.
1972-1974				
Mean of Passed Cars	4.66	75.28	2.27	13.31
Mean of Failed Cars before Maint.	6.96	96.80	1.92	14.92
Population Mean (30% Failures)	5.35	81.74	2.17	13.85
Mean of Failed Cars after Maint.	5.11	64.28	1.92	15.29
Population Mean (30% Failure)	4.80	71.98	2.17	13.96
Percent Benefit	10	12	0	-1*
1975-1976				
Mean of Passed Cars	1.79	37.96	1.77	14.42
Mean of Failed Cars before Maint.	3.65	84.98	1.46	13.88
Population Mean (30% Failure)	2.35	52.07	1.68	14.26
Mean of Failed Cars after Maint.	2.17	49.79	1.25	13.88
Population Mean (30% Failure)	1.90	41.51	1.61	14.26
Percent Benefit	19	20	4	0

* Negative percent decrease resulted from increased fuel economy.

TABLE 3.7

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 40 PERCENT STRINGENCY FACTOR - 1975 FTP

	HC	CO	NOX	F.E.
1972-1974				
Mean of Passed Cars	4.66	74.07	2.27	12.92
Mean of Failed Cars before Maint.	6.65	95.26	2.02	14.77
Population Mean (40% Failures)	5.46	82.55	2.17	13.66
Mean of Failed Cars after Maint.	5.05	64.06	1.97	15.10
Population Mean (40% Failure)	4.82	70.07	2.15	13.79
Percent Benefit	12	15	1	-1*
1975-1976				
Mean of Passed Cars	1.63	33.87	1.76	14.28
Mean of Failed Cars before Maint.	3.52	81.26	1.51	14.02
Population Mean (40% Failure)	2.39	52.83	1.66	14.18
Mean of Failed Cars after Maint.	2.12	48.28	1.30	13.98
Population Mean (40% Failure)	1.83	39.63	1.58	14.16
Percent Benefit	23	25	5	0

* Negative percent decrease resulted from increased fuel economy.

TABLE 3.8
PERCENT BENEFIT IN AN I/M PROGRAM WITH A 50 PERCENT STRINGENCY FACTOR - 1975 FTP

1972-1974	HC	CO	NOX	F.E.
Mean of Passed Cars	4.63	72.65	2.12	13.17
Mean of Failed Cars before Maint.	6.51	94.72	2.08	14.45
Population Mean (50% Failures)	5.57	83.69	2.10	13.81
Mean of Failed Cars after Maint.	4.97	64.73	2.03	14.70
Population Mean (50% Failure)	4.80	68.69	2.08	13.94
Percent Benefit	14	18	1	-1 *
1975-1976				
Mean of Passed Cars	1.51	31.93	1.77	13.79
Mean of Failed Cars before Maint.	3.44	76.26	1.55	14.16
Population Mean (50% Failure)	2.48	54.10	1.66	13.98
Mean of Failed Cars after Maint.	2.06	46.56	1.32	14.08
Population Mean (50% Failure)	1.79	39.25	1.55	13.94
Percent Benefit	28	27	7	0

* Negative percent decrease resulted from increased fuel economy.

TABLE 3.9

COMPARISON OF ESTIMATED HIGH ALTITUDE PERCENT BENEFITS WITH FIRST YEAR PERCENT BENEFITS OF APPENDIX N

		HC		CO	
	Stringency Factor	Appendix N*	High Altitude	Appendix N*	High Altitude
1972-1974 Model Years (Technology I)	0.10	3-6	6	7-11	3
	0.20	4-9	8	9-16	8
	0.30	7-12	10	12-20	12
	0.40	8-13	12	14-22	15
	0.50	8-14	14	15-23	18
1975-1976 Model Years (Technology II)	0.10	4-9	8	10-17	10
	0.20	6-13	14	17-26	16
	0.30	10-14	19	21-30	20
	0.40	12-15	23	23-32	25
	0.50	13-16	28	25-33	27

* Range of first year benefit. Low number represents no mechanic training and high number represents full mechanic training. These values are the most recent EPA estimates as of December, 1977.

TABLE 3.10

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 10 PERCENT STRINGENCY FACTOR

IDLE (N) EMISSIONS

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	200.0	3.59	56.12
Mean of Failed Cars before Maint.	1129.6	6.69	35.30
Population Mean (10% Failures)	293.0	3.90	37.38
Mean of Failed Cars after Maint.	524.7	2.12	56.16
Population Mean (10% Failure)	232.5	3.44	37.39
Percent Benefit	21	12	0
1975-1976			
Mean of Passed Cars	91.3	1.26	56.06
Mean of Failed Cars before Maint.	349.8	7.17	45.55
Population Mean (10% Failure)	117.2	1.85	55.01
Mean of Failed Cars after Maint.	102.4	0.84	62.81
Population Mean (10% Failure)	92.4	1.22	56.74
Percent Benefit	21	34	-3

TABLE 3.11

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 20 PERCENT STRINGENCY FACTOR

IDLE (N) EMISSIONS

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	179.2	3.25	56.68
Mean of Failed Cars before Maint.	824.8	7.11	39.23
Population Mean (20% Failures)	308.3	4.02	53.19
Mean of Failed Cars after Maint.	430.0	2.02	60.24
Population Mean (20% Failure)	22.94	3.00	57.39
Percent Benefit	26	25	-8
1975-1976			
Mean of Passed Cars	71.9	0.87	57.08
Mean of Failed Cars before Maint.	298.3	5.94	47.29
Population Mean (20% Failure)	117.2	1.88	55.12
Mean of Failed Cars after Maint.	94.1	0.84	64.52
Population Mean (20% Failure)	76.3	0.86	58.57
Percent Benefit	35	54	-6

TABLE 3.13

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 40 PERCENT STRINGENCY FACTOR

IDLE (N) EMISSIONS

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	143.4	2.08	55.84
Mean of Failed Cars before Maint.	575.1	6.70	45.50
Population Mean (40% Failures)	316.1	3.93	51.70
Mean of Failed Cars after Maint.	329.2	1.79	64.91
Population Mean (40% Failure)	217.7	1.96	59.47
Percent Benefit	31	50	-15
1975-1976			
Mean of Passed Cars	48.9	0.38	53.94
Mean of Failed Cars before Maint.	258.9	4.96	50.64
Population Mean (40% Failure)	132.9	2.21	52.62
Mean of Failed Cars after Maint.	86.2	0.86	66.00
Population Mean (40% Failure)	63.8	0.57	58.76
Percent Benefit	52	74	-12

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TABLE 3.14

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 50 PERCENT STRINGENCY FACTOR

IDLE (N) EMISSIONS

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	135.1	1.78	55.59
Mean of Failed Cars before Maint.	540.8	6.44	45.65
Population Mean (50% Failures)	338.0	4.11	50.62
Mean of Failed Cars after Maint.	311.2	1.76	65.19
Population Mean (50% Failure)	223.2	1.77	60.39
Percent Benefit	34	57	-19
1975-1976			
Mean of Passed Cars	38.6	0.18	57.06
Mean of Failed Cars before Maint.	233.4	4.36	49.15
Population Mean (50% Failure)	136.0	2.27	53.11
Mean of Failed Cars after Maint.	83.5	0.81	64.53
Population Mean (50% Failure)	61.0	0.50	60.80
Percent Benefit	55	78	-14

TABLE 3.15

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 10 PERCENT STRINGENCY FACTOR

COLD TRANSIENT EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	6.82	102.23	2.66
Mean of Failed Cars before Maint.	10.13	108.90	2.36
Population Mean (10% Failures)	7.15	102.90	2.63
Mean of Failed Cars after Maint.	7.93	103.94	2.03
Population Mean (10% Failure)	6.93	102.40	2.60
Percent Benefit	3	0	1
1975-1976			
Mean of Passed Cars	3.41	67.18	2.12
Mean of Failed Cars before Maint.	5.50	110.08	1.77
Population Mean (10% Failure)	3.62	71.47	2.09
Mean of Failed Cars after Maint.	4.09	83.87	1.58
Population Mean (10% Failure)	3.48	68.85	2.07
Percent Benefit	4	4	1

TABLE 3.16

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 20 PERCENT STRINGENCY FACTOR

COLD TRANSIENT EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	6.74	99.64	2.68
Mean of Failed Cars before Maint.	9.13	107.97	2.37
Population Mean (20% Failures)	7.22	101.31	2.62
Mean of Failed Cars after Maint.	7.40	94.67	2.20
Population Mean (20% Failure)	6.87	98.65	2.58
Percent Benefit	5	3	1
1975-1976			
Mean of Passed Cars	3.25	62.64	2.13
Mean of Failed Cars before Maint.	5.09	104.49	1.87
Population Mean (20% Failure)	3.62	71.01	2.08
Mean of Failed Cars after Maint.	3.88	81.58	1.61
Population Mean (20% Failure)	3.38	66.43	2.03
Percent Benefit	7	6	3

TABLE 3.17

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 30 PERCENT STRINGENCY FACTOR

COLD TRANSIENT EMISSIONS (gm/mi)

1972-1974	HC	CO	NOX
Mean of Passed Cars	6.89	101.44	2.73
Mean of Failed Cars before Maint.	8.22	106.18	2.42
Population Mean (30% Failures)	7.29	102.86	2.64
Mean of Failed Cars after Maint.	6.79	90.89	2.27
Population Mean (30 % Failure)	6.86	98.28	2.59
Percent Benefit	6	4	2
1975-1976			
Mean of Passed Cars	3.05	60.38	2.14
Mean of Failed Cars before Maint.	4.99	100.38	1.95
Population Mean (30 % Failure)	3.63	72.38	2.08
Mean of Failed Cars after Maint.	4.02	82.85	1.67
Population Mean (30 % Failure)	3.34	67.12	2.00
Percent Benefit	8	7	4

TABLE 3.18

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 40 PERCENT STRINGENCY FACTOR

COLD TRANSIENT EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	7.03	102.94	2.69
Mean of Failed Cars before Maint.	8.04	106.81	2.54
Population Mean (40 % Failures)	7.43	104.49	2.63
Mean of Failed Cars after Maint.	6.85	91.80	2.36
Population Mean (40 % Failure)	6.96	98.48	2.56
Percent Benefit	6	6	3
1975-1976			
Mean of Passed Cars	2.93	56.87	2.15
Mean of Failed Cars before Maint.	4.80	96.99	1.98
Population Mean (40 % Failure)	3.68	72.92	2.08
Mean of Failed Cars after Maint.	3.88	80.35	1.70
Population Mean (40 % Failure)	3.31	66.26	1.97
Percent Benefit	10	9	5

TABLE 3.19

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 50 PERCENT STRINGENCY FACTOR

COLD TRANSIENT EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	7.17	102.56	2.51
Mean of Failed Cars before Maint.	7.88	106.92	2.59
Population Mean (50 % Failures)	7.53	104.74	2.55
Mean of Failed Cars after Maint.	6.73	92.82	2.41
Population Mean (50 % Failure)	6.95	97.69	2.46
Percent Benefit	8	7	4
1975-1976			
Mean of Passed Cars	2.85	55.91	2.15
Mean of Failed Cars before Maint.	4.78	92.37	2.02
Population Mean (50 % Failure)	3.82	74.14	2.09
Mean of Failed Cars after Maint.	3.74	76.97	1.75
Population Mean (50 % Failure)	3.30	66.44	1.95
Percent Benefit	14	10	6

TABLE 3.20

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 10 PERCENT STRINGENCY FACTOR
COLD STABILIZED EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	4.21	77.18	1.69
Mean of Failed Cars before Maint.	9.27	97.59	1.44
Population Mean (10 % Failures)	4.72	79.22	1.67
Mean of Failed Cars after Maint.	5.43	64.33	1.44
Population Mean (10 % Failure)	4.33	75.90	1.67
Percent Benefit	8	4	0
1975-1976			
Mean of Passed Cars	1.65	37.85	1.41
Mean of Failed Cars before Maint.	3.97	102.72	1.02
Population Mean (10 % Failure)	1.88	44.34	1.37
Mean of Failed Cars after Maint.	1.56	36.69	0.98
Population Mean (10 % Failure)	1.64	37.73	1.37
Percent Benefit	13	15	0

TABLE 3.21

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 20 PERCENT STRINGENCY FACTOR

COLD STABLIZED EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	4.04	72.75	1.71
Mean of Failed Cars before Maint.	7.90	101.46	1.41
Population Mean (20% Failures)	4.81	78.49	1.65
Mean of Failed Cars after Maint.	5.17	57.94	1.52
Population Mean (20% Failure)	4.27	69.79	1.67
Percent Benefit	11	11	-1
1975-1976			
Mean of Passed Cars	1.46	32.88	1.41
Mean of Failed Cars before Maint.	3.57	91.81	1.07
Population Mean (20% Failure)	1.88	44.67	1.34
Mean of Failed Cars after Maint.	1.51	36.15	0.96
Population Mean (20% Failure)	1.47	33.53	1.32
Percent Benefit	22	25	2

TABLE 3.22

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 30 PERCENT STRINGENCY FACTOR

COLD STABILIZED EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	3.94	69.45	1.77
Mean of Failed Cars before Maint.	6.93	101.05	1.44
Population Mean (30% Failures)	4.84	78.93	1.67
Mean of Failed Cars after Maint.	4.64	55.72	1.55
Population Mean (30% Failure)	4.15	65.33	1.70
Percent Benefit	14	17	-2
1975-1976			
Mean of Passed Cars	1.31	30.20	1.44
Mean of Failed Cars before Maint.	3.40	86.39	1.10
Population Mean (30% Failure)	1.94	47.06	1.34
Mean of Failed Cars after Maint.	1.58	36.79	0.98
Population Mean (30% Failure)	1.39	32.18	1.30
Percent Benefit	28	32	3

TABLE 3.23

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 40 PERCENT STRINGENCY FACTOR

COLD STABILIZED EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	3.88	66.80	1.78
Mean of Failed Cars before Maint.	6.52	98.52	1.52
Population Mean (40 % Failures)	4.94	79.49	1.68
Mean of Failed Cars after Maint.	4.52	55.09	1.58
Population Mean (40 % Failure)	4.14	62.12	1.70
Percent Benefit	16	22	-1
1975-1976			
Mean of Passed Cars	1.09	25.20	1.42
Mean of Failed Cars before Maint.	3.27	82.09	1.17
Population Mean (40 % Failure)	1.96	47.96	1.32
Mean of Failed Cars after Maint.	1.55	35.87	1.03
Population Mean (40 % Failure)	1.27	29.47	1.26
Percent Benefit	35	39	4

TABLE 3.24

PERCENT BENEFIT IN AN I/M PROGRAM WITH A 50 PERCENT STRINGENCY FACTOR

COLD STABILIZED EMISSIONS (gm/mi)

	HC	CO	NOX
1972-1974			
Mean of Passed Cars	3.82	64.43	1.67
Mean of Failed Cars before Maint.	6.36	97.76	1.57
Population Mean (50% Failures)	5.09	81.10	1.62
Mean of Failed Cars after Maint.	4.43	55.62	1.62
Population Mean (50% Failure)	4.13	60.03	1.65
Percent Benefit	19	26	-2
1975-1976			
Mean of Passed Cars	0.94	22.64	1.46
Mean of Failed Cars before Maint.	3.14	76.21	1.18
Population Mean (50% Failure)	2.04	49.43	1.32
Mean of Failed Cars after Maint.	1.51	34.77	1.04
Population Mean (50% Failure)	1.23	28.71	1.25
Percent Benefit	40	42	5

TABLE 3.25

AVERAGE PERCENT REDUCTIONS IN 1975 FTP EMISSIONS DUE TO MAINTENANCE

ALL PHASE 1 VEHICLES
PERCENT REDUCTION

MODEL		HYDROCARBONS (%)					CARBON MONOXIDE (%)					NOX (%)					FUEL ECONOMY (%)				
YEAR	N	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE
1972	25	18	29	-29	91	121	21	29	-35	72	107	-2	31	-110	53	164	-1	9	-24	13	38
1973	27	10	19	-47	41	89	23	21	-28	53	81	-9	30	-71	55	127	-2	6	-15	9	25
1974	30	12	18	-11	73	84	22	20	-10	69	80	-6	32	-103	49	153	-1	8	-29	13	42
72-74	82	13	22	-47	91	139	22	23	-35	72	107	-6	31	-110	55	166	-2	8	-29	13	43
75-76	111	17	30	-100	86	187	17	33	-117	85	202	4	23	-105	81	186	0	8	-62	21	84

PASSING PHASE 1 VEHICLES
PERCENT REDUCTION

MODEL		HYDROCARBONS (%)					CARBON MONOXIDE (%)					NOX (%)					FUEL ECONOMY (%)				
YEAR	N	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE
1972	14	4	16	-29	28	58	7	26	-35	43	79	4	16	-24	29	54	2	6	-7	13	21
1973	16	2	20	-47	31	78	19	21	-28	53	81	-10	30	-50	44	94	-1	6	-9	9	18
1974	22	13	20	-11	73	84	22	19	-10	69	90	-10	36	-103	49	153	-2	9	-29	13	42
72-74	52	7	19	-47	73	120	17	22	-35	69	104	-6	30	-103	49	153	0	7	-29	13	43
75-76	72	9	29	-100	66	167	9	31	-117	74	192	4	22	-47	81	128	0	9	-62	21	84

FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
PERCENT REDUCTION

MODEL		HYDROCARBONS (%)					CARBON MONOXIDE (%)					NOX (%)					FUEL ECONOMY (%)				
YEAR	N	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE	MEAN	SD	MIN	MAX	RANGE
1972	50	19	33	-104	91	196	28	30	-96	72	168	-3	31	-110	53	164	-2	8	-24	19	43
1973	53	18	21	-42	60	102	27	23	-20	72	92	-7	37	-155	59	214	-2	8	-30	15	46
1974	31	17	15	-11	55	66	24	20	-4	71	76	1	28	-53	68	122	0	8	-14	26	41
72-74	134	18	25	-104	91	196	27	25	-96	72	168	-4	33	-155	68	224	-2	8	-30	26	57
75-76	124	36	26	-86	92	179	33	39	-282	85	367	9	26	-105	59	165	0	7	-21	36	57

TABLE 3.26

COMPARISONS OF AFTER MAINTENANCE EMISSIONS WITH PASSED VEHICLES' EMISSIONS

Stringency Factor	ST Cutpoints			Mean Passed FTP*			Mean Repaired FTP*			Mean Passed Idle (N)**			Mean Repaired Idle (N)**			Mean Passed Cold Transient*			Mean Repaired Cold Transient*			Mean Passed Cold Stabilized*			Mean Repaired Cold Stabilized*		
	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1972-1974 Model Years																											
10	739	9.99	-	4.81	80.33	2.19	5.83	73.66	1.76	200	3.59	56.1	525	2.12	56.2	8.82	102.23	2.66	7.93	103.94	2.03	4.21	77.10	1.69	5.43	64.33	1.44
20	599	8.19	-	4.67	76.05	2.21	5.62	66.61	1.80	179	3.25	58.7	630	2.02	60.2	6.74	99.64	2.60	7.40	94.67	2.20	4.04	72.75	1.71	5.17	57.94	1.52
30	599	6.29	-	4.66	75.20	2.27	5.11	64.20	1.92	162	2.63	56.6	336	1.83	6.29	6.09	101.44	2.73	6.79	90.09	2.27	3.94	69.45	1.77	4.64	55.72	1.55
40	389	5.39	-	4.66	74.07	2.27	5.05	64.06	1.97	143	2.08	55.0	329	1.79	64.9	7.03	102.94	2.69	6.05	91.00	2.36	3.80	66.80	1.70	4.52	55.09	1.50
50	314	4.29	111	4.63	72.65	2.12	4.97	64.73	2.03	135	1.70	55.6	311	1.76	6.52	7.17	102.36	2.51	6.73	92.02	2.41	3.82	64.43	1.67	4.43	55.62	1.62
1975-1976 Model Years																											
10	1199	5.59	-	2.11	45.97	1.73	2.50	49.49	1.23	91.3	1.26	56.1	102	0.04	62.0	3.41	67.10	2.12	4.09	83.07	1.50	1.65	37.05	1.41	1.56	38.69	0.90
20	1199	3.49	-	1.94	40.41	1.74	2.10	49.32	1.22	71.9	0.07	57.1	94.1	0.04	64.5	3.25	62.64	2.13	3.88	81.50	1.61	1.46	32.00	1.41	1.51	36.15	0.96
30	1199	2.39	-	1.79	37.96	1.77	2.17	49.79	1.25	64.0	0.61	58.1	89.7	0.07	64.9	3.05	60.30	2.14	4.02	82.05	1.67	1.31	30.20	1.44	1.50	37.79	0.90
40	394	1.69	-	1.63	33.07	1.76	2.12	48.20	1.30	48.9	0.30	53.9	86.2	0.06	66.0	2.93	56.07	2.15	3.88	80.35	1.70	1.09	25.20	1.42	1.55	35.07	1.03
50	299	0.99	-	1.51	31.93	1.27	2.06	46.56	1.32	30.6	0.10	57.1	83.5	0.01	64.5	2.85	55.91	2.15	3.74	76.97	1.75	0.94	22.64	1.46	1.51	36.77	1.04

	HC	CO	NOX
1972-1974 Standards in FTP Equivalent	3.0	34	3.1
1975 Standards	1.5	15.0	3.1

* Units are gm/mi for HC, CO, and NOX.

**Units are ppm/hex for HC and NOX, and % for CO.

TABLE 3.27

REGRESSION EQUATIONS FOR ABSOLUTE CHANGE IN FTP EMISSIONS AS A FUNCTION OF PRE-MAINTENANCE EMISSIONS LEVEL, ENGINE DISPLACEMENT, AND VEHICLE MILEAGE - ALL PHASE I

	HC				CO				NOX			
	r	a	b	c	r	a	b	c	r	a	b	c
1972-1974												
FTP	0.95	-3.85	0.953	*	0.84	-34.04	0.700	*	0.47	-0.28	0.294	-0.001
Hot FTP	0.94	-3.61	0.945	*	0.72	-27.61	0.656	*	0.45	-0.58	0.269	*
Fed. Short Cycle	0.92	-3.03	0.971	*	0.66	-14.93	0.587	*	0.46	-0.57	0.308	*
Fed. Three Mode(50)	0.94	-137	0.950	*	0.51	-0.71	0.376	*	0.47	-774	0.338	1.178
Fed. Three Mode(30)	0.93	-186	0.952	*	0.71	-1.04	0.577	*	0.55	-390	0.490	*
Fed. Three Mode(N)	0.82	-233	0.753	0.457	0.86	-0.97	0.818	*	*	*	*	*
Idle (2250)	0.89	-239	1.02	0.439	0.55	-0.43	0.394	*	0.61	-84	0.455	*
Idle (N)	0.75	-299	0.686	0.696	0.94	-1.59	0.933	0.002	0.37	-38	0.473	*
1975-1976												
FTP	0.79	-1.29	0.660	0.001	0.84	-19.76	0.682	*	0.42	-0.29	0.244	*
Hot FTP	0.85	-1.22	0.744	0.001	0.85	-16.92	0.690	*	0.39	-0.28	0.228	*
Fed. Short Cycle	0.90	-0.81	0.838	*	0.88	-11.42	0.749	*	0.53	-0.30	0.320	*
Fed. Three Mode(50)	0.40	-14	0.308	*	0.41	-0.56	0.314	*	0.51	-252	0.370	*
Fed. Three Mode(30)	0.49	-23	0.384	*	0.58	-0.79	0.536	*	0.58	-108	0.340	*
Fed. Three Mode(N)	0.79	-69	0.783	*	0.82	-0.66	0.825	*	0.54	-27	0.475	*
Idle (2250)	0.65	-12	0.447	*	0.83	-0.40	0.681	*	0.61	-47	0.434	*
Idle (N)	0.77	-55	0.548	0.149	0.93	-0.80	0.875	0.002	0.61	-39	0.625	*

Fuel Economy: 1972-1974: No significant correlation

1975-1976: r = 0.53, a = -50.6, b = 2.03, c = 0.07

Change = a + b(pre-maintenance value) + c(CID); mileage term was non-significant.

* Indicates non-significant contribution to regression equation.

TABLE 3.28

REGRESSION EQUATIONS FOR PREDICTING ABSOLUTE CHANGE IN FTP EMISSIONS AS A FUNCTION OF BEFORE MAINTENANCE SHORT TEST EMISSIONS - ALL PHASE I VEHICLES

Pollutant	Model Year	Short Test	Regression Equation*	Correlation Coefficient
HC	1972-1974	Hot FTP	$y = 3.59 + 1.00x$	0.87
		Fed. Short Cycle	$= -3.39 + 1.15x$	0.84
		Fed. Three Mode	$= -1.67+0.0118x_1+0.0016x_2+0.0013x_3$	0.86
		Idle	$= -0.74 + 0.0036x_1 + 0.0046x_2$	0.65
		Idle (N)	$= -0.61 + 0.0065x$	0.57
HC	1975-1976	Hot FTP	$y = -0.68 + 0.64x$	0.77
		Fed. Short Cycle	$= -0.41 + 0.63x$	0.74
		Fed. Three Mode	$= 0.01+0.00374x_1+0.00142x_2+0.00125x_3$	.36
		Idle	$= 0.07 + 0.00284x_1 + 0.00314x_2$	0.46
		Idle (N)	$= 0.20 + 0.0036x$	0.44
CO	1972-1974	Hot FTP	$y = -28.20 + 0.70x$	0.77
		Fed. Short Cycle	$= -14.46 + 0.68x$	0.66
		Fed. Three Mode	$= -13.42+4.41x_1+4.63x_2+3.39x_3$	0.58
		Idle	$= 2.26 + 3.86x_1 + 3.26x_2$	0.45
		Idle (N)	$= 6.34 + 4.38x$	0.42
CO	1975-1976	Hot FTP	$y = -14.55 + 0.63x$	0.81
		Fed. Short Cycle	$= -7.80 + 0.71x$	0.78
		Fed. Three Mode	$= -6.18+2.43x_1+1.52x_2+5.11x_3$	0.60
		Idle	$= -4.30 + 5.70x_1 + 6.68x_2$	0.71
		Idle (N)	$= -2.00 + 9.28x$	0.66
NOX	1972-1974	Hot FTP	$y = 0.49 + 0.23x$	0.38
		Fed. Short Cycle	$= -0.44 + 0.25x$	0.36
		Fed. Three Mode	$= -0.43 + 0.0004x_2 + 0.0006x_3$	0.37
		Idle	$= -0.21 + 0.0016x_1 - 0.0027x_2$	0.38
		Idle (N)	$= -0.18 + 0.0033x$	0.09**
NOX	1975-1976	Hot FTP	$y = -0.25 + 0.23x$	0.41
		Fed. Short Cycle	$= -0.24 + 0.26x$	0.47
		Fed. Three Mode	$= -0.06+0.0001x_1+0.0001x_2+0.0005x_3$	0.24
		Idle	$= -0.03 + 0.0015x_1 - 0.0012x_2$	0.34
		Idle (N)	$= 0.04 + 0.0016x$	0.08**

* For Fed. Three Mode x_1, x_2, x_3 refer to 50, 30, and N modes, respectively. For Idle x_1 and x_2 refer to Idle (2250) and Idle (N), respectively.

** Not significant at 95 percent level of confidence.

TABLE 3.29

REGRESSION EQUATIONS FOR PREDICTING ABSOLUTE CHANGE IN FTP EMISSIONS AS A FUNCTION OF CHANGE IN SHORT TEST EMISSIONS - ALL PHASE I VEHICLES

Pollutant	Model Year	Short Test	Regression Equation*	Correlation Coefficient
HC	1972-1974	Hot FTP	$y = 0.28 + 1.04x$	0.91
		Fed. Short Cycle	$= 0.33 + 1.10x$	0.85
		Fed. Three Mode	$= 0.37 + 0.0104x_1 + 0.004x_3$	0.85
		Idle	$= 0.43 + 0.00139x_1 + 0.00724x_2$	0.67
		Idle (N)	$= 0.43 + 0.00842$	0.66
HC	1975-1976	Hot FTP	$y = 0.08 + 0.842x$	0.91
		Fed. Short Cycle	$= 0.20 + 0.732x$	0.80
		Fed. Three Mode	$= 0.38+0.0071x_1+0.0025x_2+0.0015x_3$	0.52
		Idle	$= 0.21 + 0.0020x_1 + 0.0073x_2$	0.69
		Idle (N)	$= 0.22 + 0.0077x$	0.68
CO	1972-1974	Hot FTP	$y = 5.77 + 0.862x$	0.86
		Fed. Short Cycle	$= 6.85 + 0.951x$	0.82
		Fed. Three Mode	$= 7.61+1.92x_1+8.46x_2+4.84x_3$	0.62
		Idle	$= 7.87 + 9.91x_1 + 4.09x_2$	0.62
		Idle (N)	$= 8.55 + 5.42x$	0.50
CO	1975-1976	Hot FTP	$y = 1.36 + 0.886x$	0.93
		Fed. Short Cycle	$= 3.81 + 0.895x$	0.83
		Fed. Three Mode	$= 5.88 + 10.2x_1 - 2.89x_2 + 5.91x_3$	0.71
		Idle	$= 1.54 + 8.29x_1 + 7.62x_2$	0.78
		Idle (N)	$= 1.48 + 10.6x$	0.71
NOX	1972-1974	Hot FTP	$y = 0.935x$	0.94
		Fed. Short Cycle	$= 0.02 + 0.863x$	0.84
		Fed. Three Mode	$= -0.09+0.0002x_1+0.0007x_2-0.0014x_3$	0.67
		Idle	$= -0.13 + 0.0032x_1 - 0.0065x_2$	0.56
		Idle (N)	$= -0.01 - 0.0011x$	0.04**
NOX	1975-1976	Hot FTP	$y = 0.04 + 0.885x$	0.94
		Fed. Short Cycle	$= 0.811x$	0.88
		Fed. Three Mode	$= 0.08+0.0001x_1+0.0005x_2+0.0028x_3$	0.39
		Idle	$= 0.09 + 0.0024x_1 + 0.0005x_2$	0.42
		Idle (N)	$= 0.14 + 0.0024x$	0.13**

* For Fed. Three Mode x_1, x_2, x_3 refer to 50, 30, and neutral modes, respectively. For Idle, x_1 and x_2 refer to Idle (2250) and Idle (N), respectively.

** Not significant at 95 percent level of confidence.

TABLE 3.30

SHORT TEST CUTPOINTS BASED ON COMBINATION OF EMITTANTS ASSUMING STRINGENCY FACTORS OF 10%, 20%, 30%, 40%, and 50%

Stringency Factor		10%		20%		30%		40%		50%	
Model Year		72-74	75-76	72-74	75-76	72-74	75-76	72-74	75-76	72-74	75-76
Hot FTP	HC	29.76	--	29.76	--	8.49	--	7.04	--	7.04	--
	CO	128.09	89.06	101.31	66.47	81.30	54.33	77.48	46.31	66.74	39.02
	NOX	--	--	--	--	--	--	--	--	--	--
Fed. Short Cycle	HC	24.56	--	24.56	--	7.81	--	7.81	--	5.81	--
	CO	112.90	66.36	82.39	46.19	62.72	36.46	57.82	29.40	46.74	22.49
	NOX	--	--	--	--	--	--	--	--	--	--
Fed. Three Mode(50)	HC	329	--	214	--	194	--	179	164	159	144
	CO	7.39	4.79	5.29	3.69	4.59	2.89	4.59	2.39	4.59	1.99
	NOX	--	--	--	--	--	--	--	--	--	--
Fed. Three Mode(30)	HC	699	--	699	--	319	--	319	229	269	189
	CO	4.39	4.19	3.49	3.09	3.19	2.19	2.69	1.89	2.59	1.59
	NOX	--	--	--	--	--	--	3086	--	2787	2364
Fed. Three Mode(N)	HC	789	1999	649	899	449	899	424	459	424	289
	CO	--	7.39	9.09	4.79	7.49	3.59	6.59	2.79	5.49	1.99
	NOX	266	--	266	--	266	--	266	--	103	146
Idle (2250)	HC	459	--	319	--	239	--	204	249	159	249
	CO	6.99	3.49	4.69	2.09	3.79	1.39	3.19	0.89	2.39	0.59
	NOX	--	--	--	--	871	--	717	--	717	--
Idle (N)	HC	739	1199	599	1199	599	1199	389	394	314	299
	CO	9.99	5.59	8.19	3.49	6.29	2.39	5.39	1.69	4.29	0.99
	NOX	--	--	--	--	--	--	--	--	111	--

TABLE 3.31

IDLE (N) CUTPOINTS AND NUMBER OF FAILURES FOR VARIOUS HC/CO RATIOS AT A 30% STRINGENCY FACTOR

HC/CO Ratio	Model Year	Combined Cutpoints			Actual Failures		
		HC	CO	NOX	HC	CO	NOX
10	72-74	259	--	--	95	--	--
	75-76	149	--	--	96	--	--
5	72-74	259	--	--	95	--	--
	75-76	149	3.49	--	96	82	--
2	72-74	269	8.19	--	92	36	--
	75-76	299	2.39	--	32	98	--
0.5	72-74	1149	6.09	--	16	75	--
	75-76	1199	2.39	--	1	98	--
0.1	72-74	--	5.99	--	--	80	--
	75-76	--	2.29	--	--	102	--

TABLE 3.32

COMPARISON OF ESTIMATED PERCENT BENEFITS FOR 30% STRINGENCY FACTOR AND VARIOUS HC/CO RATIOS

	HC/CO Ratio	HC	CO	NOX
1972-1974	10	9	9	2
	5	9	9	2
	2	10	10	2
	1	10	12	0
	0.5	11	13	0
	0.1	11	14	0
	Appendix N*	7-12	12-20	
1975-1976	10	22	21	4
	5	21	21	4
	2	21	20	4
	1	19	20	4
	0.5	19	20	4
	0.1	18	20	4
	Appendix N*	10-14	21-30	

* Range of first year benefit. Low number represents no mechanic training and high humber represents full mechanic training. These values are the most recent EPA estimates as of December, 1977.

TABLE 3.33

TUNE UP INFORMATION
ALL PHASE 1 VEHICLES

DIAGNOSIS

SYSTEM	NOT APPLICABLE		SYSTEM OK		REPLACED PER SERVICE SCHEDULE		REPLACED PER DIAGNOSIS		REPAIRED		ADJUSTED	
	N	%	N	%	N	%	N	%	N	%	N	%
AIR CLEANER SERVICE	0	0.0	173	89.6	0	0.0	6	3.1	14	7.3	0	0.0
AIR CLEANER FILTER	0	0.0	138	71.5	16	8.3	39	20.2	0	0.0	0	0.0
AIR SYSTEM	123	63.7	64	33.2	0	0.0	3	1.6	3	1.6	0	0.0
AIR PUMP BELT	123	63.7	65	33.7	0	0.0	2	1.0	0	0.0	3	1.6
HEAT RISER VALVE	104	53.9	83	43.0	0	0.0	0	0.0	6	3.1	0	0.0
IDLE RPM	0	0.0	8	4.1	0	0.0	0	0.0	0	0.0	185	95.9
IDLE A/F RATIO	1	0.5	16	8.3	0	0.0	0	0.0	0	0.0	176	91.2
CHOKE ACTION	6	3.1	180	93.3	0	0.0	0	0.0	3	1.6	4	2.1
CARB. FLOAT	7	3.6	183	94.8	0	0.0	2	1.0	0	0.0	1	0.5
CARBURETOR	7	3.6	159	82.4	0	0.0	0	0.0	7	3.6	20	10.4
FUEL FILTER	0	0.0	169	87.6	14	7.3	10	5.2	0	0.0	0	0.0
FUEL PUMP	0	0.0	193	100.0	0	0.0	0	0.0	0	0.0	0	0.0
FILLER CAP	0	0.0	191	99.0	0	0.0	2	1.0	0	0.0	0	0.0
FUEL SYSTEM	0	0.0	193	100.0	0	0.0	0	0.0	0	0.0	0	0.0
EVAP. CONTAINER	3	1.6	156	80.8	13	6.7	21	10.9	0	0.0	0	0.0
PCV SYSTEM	1	0.5	152	78.8	14	7.3	17	8.8	8	4.1	1	0.5
EGR SYSTEM	38	19.7	142	73.6	0	0.0	4	2.1	9	4.7	0	0.0
EXHAUST SYSTEM	0	0.0	191	99.0	0	0.0	0	0.0	2	1.0	0	0.0
VACUUM SYSTEM	0	0.0	168	87.0	0	0.0	0	0.0	25	13.0	0	0.0
ELEC. IGNITION	87	45.1	106	54.9	0	0.0	0	0.0	0	0.0	0	0.0
DISTRIBUTOR CAP	0	0.0	191	99.0	2	1.0	0	0.0	0	0.0	0	0.0
ROTOR	0	0.0	190	98.4	2	1.0	1	0.5	0	0.0	0	0.0
POINTS	106	54.9	62	32.1	6	3.1	7	3.6	0	0.0	12	6.2
ADVANCE MECHANISM	0	0.0	188	97.4	0	0.0	2	1.0	3	1.6	0	0.0
IGNITION WIRES	0	0.0	189	97.9	0	0.0	4	2.1	0	0.0	0	0.0
ELECTRICAL WIRES	0	0.0	188	97.4	0	0.0	1	0.5	4	2.1	0	0.0
COIL	0	0.0	192	99.5	1	0.5	0	0.0	0	0.0	0	0.0
CONDENSER	106	54.9	77	39.9	4	2.1	6	3.1	0	0.0	0	0.0
SPARK PLUGS	0	0.0	151	78.2	22	11.4	16	8.3	0	0.0	4	2.1
TIMING	0	0.0	44	22.8	0	0.0	0	0.0	0	0.0	149	77.2
DWELL	107	55.4	34	17.6	0	0.0	0	0.0	0	0.0	52	26.9

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.34

TUNE UP INFORMATION
PASSING PHASE I VEHICLES

DIAGNOSIS

SYSTEM	NOT APPLICABLE		SYSTEM OK		REPLACED PER SERVICE SCHEDULE		REPLACED PER DIAGNOSIS		REPAIRED		ADJUSTED	
	N	%	N	%	N	%	N	%	N	%	N	%
AIR CLEANER SERVICE	0	0.0	117	94.4	0	0.0	2	1.6	5	4.0	0	0.0
AIR CLEANER FILTER	0	0.0	91	73.4	12	9.7	21	16.9	0	0.0	0	0.0
AIR SYSTEM	64	51.6	55	44.4	0	0.0	3	2.4	2	1.6	0	0.0
AIR PUMP BELT	64	51.6	55	44.4	0	0.0	2	1.6	0	0.0	3	2.4
HEAT RISER VALVE	70	56.5	52	41.9	0	0.0	0	0.0	2	1.6	0	0.0
IDLE RPM	0	0.0	8	6.5	0	0.0	0	0.0	0	0.0	116	93.5
IDLE A/F RATIO	0	0.0	15	12.1	0	0.0	0	0.0	0	0.0	109	87.9
CHOKE ACTION	3	2.4	116	93.5	0	0.0	0	0.0	1	0.8	4	3.2
CARB. FLOAT	4	3.2	117	94.4	0	0.0	2	1.6	0	0.0	1	0.8
CARBURETOR	4	3.2	107	86.3	0	0.0	0	0.0	4	3.2	9	7.3
FUEL FILTER	0	0.0	109	87.9	8	6.5	7	5.6	0	0.0	0	0.0
FUEL PUMP	0	0.0	124	100.0	0	0.0	0	0.0	0	0.0	0	0.0
FILLER CAP	0	0.0	123	99.2	0	0.0	1	0.8	0	0.0	0	0.0
FUEL SYSTEM	0	0.0	124	100.0	0	0.0	0	0.0	0	0.0	0	0.0
EVAP. CONTAINER	1	0.8	105	84.7	6	4.8	12	9.7	0	0.0	0	0.0
PCV SYSTEM	0	0.0	99	79.8	10	8.1	10	8.1	4	3.2	1	0.8
EGR SYSTEM	23	18.5	94	75.8	0	0.0	0	0.0	7	5.6	0	0.0
EXHAUST SYSTEM	0	0.0	122	98.4	0	0.0	0	0.0	2	1.6	0	0.0
VACUUM SYSTEM	0	0.0	108	87.1	0	0.0	0	0.0	16	12.9	0	0.0
ELEC. IGNITION	58	46.8	66	53.2	0	0.0	0	0.0	0	0.0	0	0.0
DISTRIBUTOR CAP	0	0.0	122	98.4	2	1.6	0	0.0	0	0.0	0	0.0
ROTOR	0	0.0	122	98.4	2	1.6	0	0.0	0	0.0	0	0.0
POINTS	66	53.2	45	36.3	3	2.4	2	1.6	0	0.0	8	6.5
ADVANCE MECHANISM	0	0.0	123	99.2	0	0.0	0	0.0	1	0.8	0	0.0
IGNITION WIRES	0	0.0	123	99.2	0	0.0	1	0.8	0	0.0	0	0.0
ELECTRICAL WIRES	0	0.0	120	96.8	0	0.0	1	0.8	3	2.4	0	0.0
COIL	0	0.0	123	99.2	1	0.8	0	0.0	0	0.0	0	0.0
CONDENSER	66	53.2	55	44.4	2	1.6	1	0.8	0	0.0	0	0.0
SPARK PLUGS	0	0.0	100	80.6	16	12.9	7	5.6	0	0.0	1	0.8
TIMING	0	0.0	32	25.8	0	0.0	0	0.0	0	0.0	92	74.2
DWELL	67	54.0	23	18.5	0	0.0	0	0.0	0	0.0	34	27.4

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.35

TUNE UP INFORMATION
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES

	DIAGNOSIS											
	NOT APPLICABLE		SYSTEM OK		REPLACED PER SERVICE SCHEDULE		REPLACED PER DIAGNOSIS		REPAIRED		ADJUSTED	
SYSTEM	N	%	N	%	N	%	N	%	N	%	N	%
AIR CLEANER SERVICE	1	0.4	232	89.9	0	0.0	10	3.9	15	5.8	0	0.0
AIR CLEANER FILTER	0	0.0	198	76.7	10	3.9	50	19.4	0	0.0	0	0.0
AIR SYSTEM	222	86.0	33	12.8	0	0.0	1	0.4	2	0.8	0	0.0
AIR PUMP BELT	222	86.0	36	14.0	0	0.0	0	0.0	0	0.0	0	0.0
HEAT RISER VALVE	134	51.9	116	45.0	0	0.0	0	0.0	8	3.1	0	0.0
IDLE RPM	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0	257	99.6
IDLE A/F RATIO	1	0.4	2	0.8	0	0.0	0	0.0	0	0.0	255	98.8
CHOKE ACTION	10	3.9	238	92.2	0	0.0	0	0.0	7	2.7	3	1.2
CARB. FLOAT	10	3.9	240	96.1	0	0.0	0	0.0	0	0.0	0	0.0
CARBURETOR	10	3.9	213	82.6	0	0.0	0	0.0	14	5.4	21	8.1
FUEL FILTER	0	0.0	224	86.8	28	10.9	6	2.3	0	0.0	0	0.0
FUEL PUMP	0	0.0	258	100.0	0	0.0	0	0.0	0	0.0	0	0.0
FILLER CAP	0	0.0	256	99.2	0	0.0	2	0.8	0	0.0	0	0.0
FUEL SYSTEM	0	0.0	256	99.2	0	0.0	1	0.4	1	0.4	0	0.0
EVAP. CONTAINER	7	2.7	210	81.4	16	6.2	25	9.7	0	0.0	0	0.0
PCV SYSTEM	3	1.2	208	80.6	16	6.2	22	8.5	9	3.5	0	0.0
EGR SYSTEM	66	25.6	170	65.9	0	0.0	6	2.3	16	6.2	0	0.0
EXHAUST SYSTEM	0	0.0	257	99.6	0	0.0	0	0.0	1	0.4	0	0.0
VACUUM SYSTEM	0	0.0	220	85.3	0	0.0	0	0.0	38	14.7	0	0.0
ELEC. IGNITION	122	47.3	136	52.7	0	0.0	0	0.0	0	0.0	0	0.0
DISTRIBUTOR CAP	0	0.0	251	97.3	0	0.0	7	2.7	0	0.0	0	0.0
ROTOR	0	0.0	251	97.3	2	0.8	5	1.9	0	0.0	0	0.0
POINTS	136	52.7	83	32.2	11	4.3	16	6.2	0	0.0	12	4.7
ADVANCE MECHANISM	0	0.0	245	95.0	0	0.0	5	1.9	8	3.1	0	0.0
IGNITION WIRES	0	0.0	247	95.7	0	0.0	11	4.3	0	0.0	0	0.0
ELECTRICAL WIRES	0	0.0	257	99.6	0	0.0	0	0.0	1	0.4	0	0.0
COIL	0	0.0	258	100.0	0	0.0	0	0.0	0	0.0	0	0.0
CONDENSER	136	52.7	109	42.2	5	1.9	8	3.1	0	0.0	18	7.0
SPARK PLUGS	0	0.0	198	76.7	22	8.5	20	7.8	0	0.0	222	86.0
TIMING	0	0.0	36	14.0	0	0.0	0	0.0	0	0.0	72	27.9
DWELL	136	52.7	50	19.4	0	0.0	0	0.0	0	0.0		

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.36

TUNE UP INFORMATION
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR

DIAGNOSIS

MANUFACTURER	N	SYSTEM	NOT APPLICABLE		SYSTEM OK		REPLACED PER SERVICE SCHEDULE		REPLACED PER DIAGNOSIS		REPAIRED		ADJUSTED	
			N	%	N	%	N	%	N	%	N	%	N	%
GENERAL MOTORS	40	IDLE RPM	0	0.0	3	7.5	0	0.0	0	0.0	0	0.0	37	92.5
		IDLE A/F RATIO	0	0.0	3	7.5	0	0.0	0	0.0	0	0.0	37	92.5
		TIMING	0	0.0	16	40.0	0	0.0	0	0.0	0	0.0	24	60.0
		DWELL	40	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FORD	25	IDLE RPM	0	0.0	1	4.0	0	0.0	0	0.0	0	0.0	24	96.0
		IDLE A/F RATIO	0	0.0	4	16.0	0	0.0	0	0.0	0	0.0	21	84.0
		TIMING	0	0.0	8	32.0	0	0.0	0	0.0	0	0.0	17	68.0
		DWELL	25	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CHRYSLER	15	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	100.0
		IDLE A/F RATIO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	100.0
		TIMING	0	0.0	2	13.3	0	0.0	0	0.0	0	0.0	13	86.7
		DWELL	15	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
AMERICAN MOTORS	6	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	100.0
		IDLE A/F RATIO	0	0.0	1	16.7	0	0.0	0	0.0	0	0.0	5	83.3
		TIMING	0	0.0	2	33.3	0	0.0	0	0.0	0	0.0	4	66.7
		DWELL	6	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FOREIGN	25	IDLE RPM	0	0.0	4	16.0	0	0.0	0	0.0	0	0.0	21	84.0
		IDLE A/F RATIO	1	4.0	5	20.0	0	0.0	0	0.0	0	0.0	19	76.0
		TIMING	0	0.0	6	24.0	0	0.0	0	0.0	0	0.0	19	76.0
		DWELL	7	28.0	10	40.0	0	0.0	0	0.0	0	0.0	8	32.0

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.37

TUNE UP INFORMATION
PASSING PHASE I VEHICLES
1975-1976 MODEL YEAR

DIAGNOSIS

MANUFACTURER	N	SYSTEM	NOT APPLICABLE N	NOT APPLICABLE %	SYSTEM OK N	SYSTEM OK %	REPLACED PER SERVICE SCHEDULE N	REPLACED PER SERVICE SCHEDULE %	REPLACED PER DIAGNOSIS N	REPLACED PER DIAGNOSIS %	REPAIRED N	REPAIRED %	ADJUSTED N	ADJUSTED %
GENERAL MOTORS	27	IDLE RPM	0	0.0	3	11.1	0	0.0	0	0.0	0	0.0	24	88.9
		IDLE A/F RATIO	0	0.0	3	11.1	0	0.0	0	0.0	0	0.0	24	88.9
		TIMING	0	0.0	12	44.4	0	0.0	0	0.0	0	0.0	15	55.6
		DWELL	27	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FORD	20	IDLE RPM	0	0.0	1	5.0	0	0.0	0	0.0	0	0.0	19	95.0
		IDLE A/F RATIO	0	0.0	4	20.0	0	0.0	0	0.0	0	0.0	16	80.0
		TIMING	0	0.0	7	35.0	0	0.0	0	0.0	0	0.0	13	65.0
		DWELL	20	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CHRYSLER	5	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	100.0
		IDLE A/F RATIO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	100.0
		TIMING	0	0.0	1	20.0	0	0.0	0	0.0	0	0.0	4	80.0
		DWELL	5	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
AMERICAN MOTORS	2	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	100.0
		IDLE A/F RATIO	0	0.0	1	50.0	0	0.0	0	0.0	0	0.0	1	50.0
		TIMING	0	0.0	1	50.0	0	0.0	0	0.0	0	0.0	1	50.0
		DWELL	2	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FOREIGN	18	IDLE RPM	0	0.0	4	22.2	0	0.0	0	0.0	0	0.0	14	77.8
		IDLE A/F RATIO	0	0.0	4	22.2	0	0.0	0	0.0	0	0.0	14	77.8
		TIMING	0	0.0	5	27.8	0	0.0	0	0.0	0	0.0	13	72.2
		DWELL	4	22.2	7	38.9	0	0.0	0	0.0	0	0.0	7	38.9

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.38

TUNE UP INFORMATION
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
1975-1976 MODEL YEAR

DIAGNOSIS

MANUFACTURER	N	SYSTEM	NOT APPLICABLE N	NOT APPLICABLE %	SYSTEM OK N	SYSTEM OK %	REPLACED PER SERVICE SCHEDULE N	REPLACED PER SERVICE SCHEDULE %	REPLACED PER DIAGNOSIS N	REPLACED PER DIAGNOSIS %	REPAIRED N	REPAIRED %	ADJUSTED N	ADJUSTED %
GENERAL MOTORS	56	IDLE RPM	0	0.0	1	1.8	0	0.0	0	0.0	0	0.0	55	98.2
		IDLE A/F RATIO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	56	100.0
		TIMING	0	0.0	13	23.2	0	0.0	0	0.0	0	0.0	43	76.8
		DWELL	56	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FORD	16	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	16	100.0
		IDLE A/F RATIO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	16	100.0
		TIMING	0	0.0	3	18.8	0	0.0	0	0.0	0	0.0	13	81.3
		DWELL	16	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
CHRYSLER	29	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	29	100.0
		IDLE A/F RATIO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	29	100.0
		TIMING	0	0.0	6	20.7	0	0.0	0	0.0	0	0.0	23	79.3
		DWELL	29	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
AMERICAN MOTORS	9	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	100.0
		IDLE A/F RATIO	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	100.0
		TIMING	0	0.0	2	22.2	0	0.0	0	0.0	0	0.0	7	77.8
		DWELL	9	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
FOREIGN	14	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	14	100.0
		IDLE A/F RATIO	1	7.1	1	7.1	0	0.0	0	0.0	0	0.0	12	85.7
		TIMING	0	0.0	3	21.4	0	0.0	0	0.0	0	0.0	11	78.6
		DWELL	3	21.4	7	50.0	0	0.0	0	0.0	0	0.0	4	28.6

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.39

TUNE UP INFORMATION
ALL PHASE 1 VEHICLES

			DIAGNOSIS											
			NOT APPLICABLE		SYSTEM OK		REPLACED PER SERVICE SCHEDULE		REPLACED PER DIAGNOSIS		REPAIRED		ADJUSTED	
	N	SYSTEM	N	%	N	%	N	%	N	%	N	%	N	%
1972-1974 MODEL YEAR	82	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	82	100.0
		IDLE A/F RATIO	0	0.0	3	3.7	0	0.0	0	0.0	0	0.0	79	96.3
		TIMING	0	0.0	10	12.2	0	0.0	0	0.0	0	0.0	72	87.8
		DWELL	14	17.1	24	29.3	0	0.0	0	0.0	0	0.0	44	53.7
1975-1976 MODEL YEAR	111	IDLE RPM	0	0.0	8	7.2	0	0.0	0	0.0	0	0.0	103	92.8
		IDLE A/F RATIO	1	0.9	13	11.7	0	0.0	0	0.0	0	0.0	97	87.4
		TIMING	0	0.0	34	30.6	0	0.0	0	0.0	0	0.0	77	69.4
		DWELL	93	83.8	10	9.0	0	0.0	0	0.0	0	0.0	8	7.2

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.40

TUNE UP INFORMATION
PASSING PHASE 1 VEHICLES

			DIAGNOSIS											
			NOT APPLICABLE		SYSTEM OK		REPLACED PER SERVICE SCHEDULE		REPLACED PER DIAGNOSIS		REPAIRED		ADJUSTED	
	N	SYSTEM	N	%	N	%	N	%	N	%	N	%	N	%
1972-1974 MODEL YEAR	52	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	52	100.0
		IDLE A/F RATIO	0	0.0	3	5.8	0	0.0	0	0.0	0	0.0	49	94.2
		TIMING	0	0.0	6	11.5	0	0.0	0	0.0	0	0.0	46	88.5
		DWELL	9	17.3	16	30.8	0	0.0	0	0.0	0	0.0	27	51.9
1975-1976 MODEL YEAR	72	IDLE RPM	0	0.0	8	11.1	0	0.0	0	0.0	0	0.0	64	88.9
		IDLE A/F RATIO	0	0.0	12	16.7	0	0.0	0	0.0	0	0.0	60	83.3
		TIMING	0	0.0	26	36.1	0	0.0	0	0.0	0	0.0	46	63.9
		DWELL	58	80.6	7	9.7	0	0.0	0	0.0	0	0.0	7	9.7

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.41

TUNE UP INFORMATION
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES

	N	SYSTEM	DIAGNOSIS NOT APPLICABLE N	%	SYSTEM OK N	%	REPLACED PER SERVICE SCHEDULE N	%	REPLACED PER DIAGNOSIS N	%	REPAIRED N	%	ADJUSTED N	%
1972-1974 MODEL YEAR	134	IDLE RPM	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	134	100.0
		IDLE A/F RATIO	0	0.0	1	0.7	0	0.0	0	0.0	0	0.0	133	99.3
		TIMING	0	0.0	9	6.7	0	0.0	0	0.0	0	0.0	125	93.3
		DWELL	23	17.2	43	32.1	0	0.0	0	0.0	0	0.0	68	50.7
1975-1976 MODEL YEAR	124	IDLE RPM	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	123	99.2
		IDLE A/F RATIO	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0	122	98.4
		TIMING	0	0.0	27	21.8	0	0.0	0	0.0	0	0.0	97	78.2
		DWELL	113	91.1	7	5.6	0	0.0	0	0.0	0	0.0	4	3.2

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.42

VEHICLE TUNEUP COST SUMMARY BY MODEL YEAR
ALL PHASE 1 VEHICLES

MODEL YEAR	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1972	25	PARTS	12.80	14.72	1.59	7.23	3.39	9.98	17.79	17.80
		LABOR	28.40	11.16	1.08	2.84	3.40	8.34	32.89	12.09
		TOTAL	41.21	22.82	2.67	9.25	6.79	17.34	50.67	25.15
1973	27	PARTS	10.18	11.22	0.00	0.00	4.48	9.33	14.66	13.47
		LABOR	24.50	9.78	0.90	2.62	5.30	10.01	30.70	12.86
		TOTAL	34.68	18.73	0.90	2.62	9.78	19.02	45.36	23.79
1974	30	PARTS	6.65	8.43	0.28	1.52	3.58	7.07	10.51	11.25
		LABOR	22.45	9.96	1.35	3.23	3.69	6.95	27.49	13.06
		TOTAL	29.11	15.30	1.63	4.27	7.27	13.47	38.01	21.23
72-74	82	PARTS	9.69	11.68	0.59	4.09	3.82	8.69	14.10	14.37
		LABOR	24.94	10.45	1.12	2.89	4.13	8.41	30.19	12.75
		TOTAL	34.63	19.38	1.71	5.88	7.95	16.49	44.29	23.62
75-76	111	PARTS	2.47	6.12	0.08	0.80	2.15	5.91	4.69	9.22
		LABOR	15.56	9.90	2.44	5.56	3.49	7.41	21.49	13.60
		TOTAL	18.02	13.57	2.52	5.76	5.64	12.92	26.18	20.53

TABLE 3.43

VEHICLE TUNEUP COST SUMMARY BY MODEL YEAR
PASSING PHASE 1 VEHICLES

MODEL YEAR	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1972	14	PARTS	6.45	10.72	0.00	0.00	2.52	9.43	8.97	12.99
		LABOR	25.65	9.44	0.58	2.16	2.41	9.02	28.64	8.99
		TOTAL	32.10	17.48	0.58	2.16	4.93	18.45	37.61	19.38
1973	16	PARTS	6.94	8.47	0.00	0.00	4.53	7.81	11.48	12.86
		LABOR	22.53	7.59	0.59	2.36	5.40	8.61	28.52	12.92
		TOTAL	29.47	16.24	0.59	2.36	9.93	15.81	40.00	23.57
1974	22	PARTS	8.68	8.96	0.00	0.00	3.92	7.89	12.61	11.99
		LABOR	22.70	10.81	1.10	2.96	4.17	7.84	27.98	14.42
		TOTAL	31.39	16.93	1.10	2.96	8.10	15.08	40.59	23.26
72-74	52	PARTS	7.55	9.17	0.00	0.00	3.73	8.18	11.28	12.38
		LABOR	23.44	9.99	0.80	2.55	4.08	8.32	28.32	12.47
		TOTAL	30.99	16.57	0.80	2.55	7.81	16.05	39.60	21.99
75-76	72	PARTS	1.80	5.08	0.00	0.00	2.58	6.47	4.37	9.14
		LABOR	15.47	10.82	2.55	6.35	3.69	8.00	21.71	15.52
		TOTAL	17.27	14.29	2.55	6.35	6.27	14.08	26.09	22.71

TABLE 3.44

VEHICLE TUNEUP COST SUMMARY BY MODEL YEAR
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES

MODEL YEAR	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1972	50	PARTS	11.13	13.30	1.58	7.05	3.11	8.22	15.83	17.53
		LABOR	26.78	10.64	0.99	2.92	3.19	6.80	30.96	11.09
		TOTAL	37.92	20.70	2.57	9.58	6.30	13.86	46.78	24.31
1973	53	PARTS	6.91	10.04	0.07	0.47	3.84	8.56	10.82	11.92
		LABOR	24.55	10.64	0.79	3.20	4.05	8.45	29.39	10.14
		TOTAL	31.47	17.90	0.85	3.62	7.89	16.25	40.22	19.07
1974	31	PARTS	4.24	7.63	0.37	1.58	2.32	4.86	6.94	9.27
		LABOR	23.17	10.82	1.05	3.03	3.92	8.33	28.13	9.38
		TOTAL	27.41	15.43	1.42	4.41	6.24	11.48	35.07	16.15
72-74	134	PARTS	7.87	11.19	0.70	4.41	3.22	7.69	11.79	14.14
		LABOR	25.07	10.70	0.92	3.04	3.70	7.79	29.68	10.32
		TOTAL	32.94	18.82	1.62	6.62	6.92	14.29	41.48	20.97
75-76	124	PARTS	3.03	6.74	0.07	0.76	1.51	4.64	4.61	8.69
		LABOR	20.01	8.34	0.77	2.36	3.19	7.23	23.97	8.56
		TOTAL	23.04	11.56	0.84	2.81	4.70	11.46	28.59	14.99

TABLE 3.45

VEHICLE TUNEUP COST SUMMARY BY MANUFACTURER
ALL PHASE 1 VEHICLES

			EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
MANUFACTURER	N		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
GENERAL MOTORS	76	PARTS	7.73	11.12	0.00	0.00	2.94	5.99	10.67	13.11
		LABOR	20.66	12.49	0.91	2.32	3.48	6.53	25.05	15.13
		TOTAL	28.39	21.31	0.91	2.32	6.42	12.58	35.71	25.71
FORD	44	PARTS	3.36	5.80	1.20	5.67	2.90	7.45	7.46	12.33
		LABOR	19.42	9.63	2.39	3.92	3.74	7.85	25.56	13.21
		TOTAL	22.78	13.18	3.60	8.18	6.64	15.04	33.01	22.98
CHRYSLER	25	PARTS	8.07	12.27	0.15	0.75	2.32	4.64	10.54	14.08
		LABOR	22.25	11.64	2.70	5.90	3.73	6.02	28.67	14.26
		TOTAL	30.32	20.09	2.85	5.91	6.05	9.94	39.22	22.90
AMERICAN MOTORS	9	PARTS	5.13	8.06	0.00	0.00	1.65	4.95	6.78	10.15
		LABOR	12.90	9.23	4.20	5.12	3.15	4.77	20.25	11.87
		TOTAL	18.03	16.32	4.20	5.12	4.80	9.25	27.03	20.36
FOREIGN	39	PARTS	2.18	6.52	0.00	0.00	3.29	9.32	5.47	10.70
		LABOR	17.31	9.28	2.15	7.07	4.50	11.31	23.95	12.38
		TOTAL	19.49	13.46	2.15	7.07	7.79	20.45	29.42	20.74

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.46

VEHICLE TUNEUP COST SUMMARY BY MANUFACTURER
PASSING PHASE 1 VEHICLES

			EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
MANUFACTURER	N		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
GENERAL MOTORS	55	PARTS	6.99	9.44	0.00	0.00	3.25	6.73	10.24	12.29
		LABOR	20.23	12.33	0.79	2.20	3.80	6.86	24.82	15.33
		TOTAL	27.22	19.80	0.79	2.20	7.05	12.94	35.06	25.57
FORD	32	PARTS	2.74	5.32	0.00	0.00	3.60	8.49	6.34	10.83
		LABOR	18.60	9.49	1.35	2.81	4.26	8.75	24.22	14.33
		TOTAL	21.35	12.64	1.35	2.81	7.86	17.07	30.56	23.62
CHRYSLER	9	PARTS	3.01	7.73	0.00	0.00	0.63	1.89	3.64	7.59
		LABOR	26.10	13.62	4.80	9.13	1.80	4.48	32.70	18.76
		TOTAL	29.11	19.23	4.80	9.13	2.43	4.99	36.34	22.21
AMERICAN MOTORS	3	PARTS	2.94	5.10	0.00	0.00	4.95	8.57	7.89	13.67
		LABOR	9.45	2.70	4.05	7.01	4.50	7.79	18.00	9.95
		TOTAL	12.39	7.56	4.05	7.01	9.45	16.36	25.89	21.61
FOREIGN	25	PARTS	0.54	1.62	0.00	0.00	2.62	7.87	3.16	7.85
		LABOR	14.47	7.92	3.35	8.65	4.10	10.87	21.92	11.84
		TOTAL	15.01	8.35	3.35	8.65	6.72	18.54	25.08	17.40

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.47

VEHICLE TUNEUP COST SUMMARY BY MANUFACTURER
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES

MANUFACTURER	N		EMISSION RELATED TUNEUP COSTS MEAN	SD	MALADJUSTMENT/ DISABLEMENT COSTS MEAN	SD	MANUFACTURER RECOMMENDED MAINTENANCE MEAN	SD	TOTAL COSTS PER VEHICLE MEAN	SD
GENERAL MOTORS	93	PARTS	5.86	9.92	0.00	0.00	3.22	7.78	9.07	12.56
		LABOR	23.02	10.01	0.28	1.33	3.99	8.03	27.29	10.61
		TOTAL	28.88	16.73	0.28	1.33	7.21	14.84	36.36	20.20
FORD	52	PARTS	5.77	9.28	1.77	7.03	2.14	5.60	9.69	14.43
		LABOR	22.33	9.48	1.86	3.85	3.25	6.89	27.43	7.18
		TOTAL	28.10	14.71	3.63	10.03	5.38	11.10	37.11	17.91
CHRYSLER	58	PARTS	5.34	9.51	0.18	0.77	1.75	4.01	7.27	11.13
		LABOR	22.51	8.62	1.05	3.38	2.30	4.49	25.86	9.43
		TOTAL	27.85	15.61	1.23	3.95	4.05	8.01	33.13	18.26
AMERICAN MOTORS	14	PARTS	7.76	13.42	0.00	0.00	0.09	0.33	7.85	13.37
		LABOR	23.34	14.02	1.83	3.65	2.02	4.06	27.19	12.67
		TOTAL	31.10	24.65	1.83	3.65	2.11	4.33	35.04	23.68
FOREIGN	41	PARTS	4.09	8.09	0.00	0.00	2.59	7.83	6.67	10.45
		LABOR	22.09	10.94	0.26	1.22	4.61	10.76	26.97	11.23
		TOTAL	26.18	16.51	0.26	1.22	7.20	17.73	33.64	19.98

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.48

VEHICLE TUNEUP COST SUMMARY BY MILEAGE
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR

MILEAGE	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LESS THAN 20000	23	PARTS	4.98	6.87	0.36	1.74	4.82	10.09	10.16	12.62
		LABOR	20.48	8.68	1.23	3.28	5.22	8.98	26.94	13.29
		TOTAL	25.47	11.24	1.60	4.59	10.04	18.13	37.10	21.13
20000 TO 30000	13	PARTS	6.70	8.74	0.00	0.00	7.21	11.66	13.90	12.69
		LABOR	25.96	11.16	0.83	2.03	8.62	13.56	35.41	13.29
		TOTAL	32.66	17.92	0.83	2.03	15.82	25.07	49.31	24.83
30000 TO 40000	20	PARTS	10.90	14.37	1.80	8.07	2.14	5.23	14.84	18.23
		LABOR	24.91	12.47	1.01	3.12	3.10	6.86	29.02	15.21
		TOTAL	35.80	24.70	2.82	10.34	5.24	11.67	43.86	30.07
40000 TO 50000	14	PARTS	9.68	10.77	0.00	0.00	4.71	10.07	14.40	13.25
		LABOR	24.30	7.18	1.16	2.94	3.18	5.04	28.64	9.22
		TOTAL	33.98	14.97	1.16	2.94	7.90	14.81	43.03	19.97
GREATER THAN 50000	12	PARTS	19.96	12.60	0.31	1.08	0.00	0.00	20.27	13.02
		LABOR	33.19	8.37	1.35	2.88	0.00	0.00	34.54	8.37
		TOTAL	53.15	16.89	1.66	3.08	0.00	0.00	54.81	15.94

VEHICLE TUNEUP COST SUMMARY BY MILEAGE
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR

MILEAGE	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LESS THAN 5000	12	PARTS	0.63	2.19	0.00	0.00	0.00	0.00	0.63	2.19
		LABOR	14.06	7.97	2.25	3.75	0.34	1.17	16.65	10.11
		TOTAL	14.69	7.75	2.25	3.75	0.34	1.17	17.28	9.76
5000 TO 10000	33	PARTS	0.78	3.19	0.00	0.00	0.13	0.76	0.91	3.25
		LABOR	13.09	7.03	3.44	7.62	1.84	3.30	18.37	9.89
		TOTAL	13.87	7.76	3.44	7.62	1.97	3.58	19.28	10.74
10000 TO 15000	25	PARTS	2.76	6.52	0.00	0.00	4.66	7.62	7.42	11.29
		LABOR	15.17	9.79	2.54	3.88	6.48	10.31	24.19	13.85
		TOTAL	17.93	14.80	2.54	3.88	11.14	17.50	31.61	23.98
15000 TO 20000	23	PARTS	3.99	6.67	0.37	1.77	0.30	1.19	4.66	6.99
		LABOR	16.61	9.77	2.58	6.33	0.88	2.92	20.07	14.28
		TOTAL	20.60	11.48	2.95	7.18	1.18	3.35	24.73	16.17
GREATER THAN 20000	18	PARTS	4.42	9.35	0.00	0.00	6.16	9.94	10.58	14.03
		LABOR	20.25	14.22	0.45	1.39	7.80	10.89	28.50	17.65
		TOTAL	24.67	21.50	0.45	1.39	13.96	20.43	39.08	30.46

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.49

VEHICLE TUNEUP COST SUMMARY BY MILEAGE
PASSING PHASE 1 VEHICLES
1972-1974 MODEL YEAR

MILEAGE	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LESS THAN 20000	16	PARTS	6.31	7.76	0.00	0.00	6.13	11.70	12.43	14.10
		LABOR	19.57	8.16	1.10	3.01	5.32	9.58	25.99	11.94
		TOTAL	25.88	11.62	1.10	3.01	11.44	20.89	38.42	22.46
20000 TO 30000	10	PARTS	8.70	9.08	0.00	0.00	4.70	7.85	13.40	11.14
		LABOR	25.78	12.03	0.54	1.71	6.62	10.88	32.94	11.94
		TOTAL	34.49	19.77	0.54	1.71	11.32	18.66	46.34	21.97
30000 TO 40000	12	PARTS	3.82	5.11	0.00	0.00	2.35	5.51	6.17	9.27
		LABOR	20.92	10.04	0.90	3.12	3.82	8.34	25.65	16.40
		TOTAL	24.74	13.40	0.90	3.12	6.18	13.51	31.82	23.83
40000 TO 50000	9	PARTS	7.75	10.41	0.00	0.00	2.32	5.64	10.06	13.16
		LABOR	25.05	8.49	0.00	0.00	1.65	3.43	26.70	9.56
		TOTAL	32.80	16.58	0.00	0.00	3.97	8.96	36.76	20.84
GREATER THAN 50000	5	PARTS	17.79	13.93	0.00	0.00	0.00	0.00	17.79	13.93
		LABOR	34.29	5.37	1.62	3.62	0.00	0.00	35.91	5.37
		TOTAL	52.08	16.02	1.62	3.62	0.00	0.00	53.70	13.76

VEHICLE TUNEUP COST SUMMARY BY MILEAGE
PASSING PHASE 1 VEHICLES
1975-1976 MODEL YEAR

MILEAGE	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LESS THAN 5000	10	PARTS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		LABOR	15.25	8.25	2.02	3.78	0.40	1.28	17.68	10.73
		TOTAL	15.25	8.25	2.02	3.78	0.40	1.28	17.68	10.73
5000 TO 10000	21	PARTS	0.08	0.35	0.00	0.00	0.21	0.95	0.28	1.00
		LABOR	10.99	5.04	4.05	9.20	1.48	2.56	16.52	10.62
		TOTAL	11.07	5.17	4.05	9.20	1.69	3.12	16.80	10.79
10000 TO 15000	15	PARTS	4.19	8.12	0.00	0.00	5.64	7.69	9.83	12.90
		LABOR	16.74	10.77	1.98	3.85	7.74	11.46	26.46	15.87
		TOTAL	20.93	17.52	1.98	3.85	13.38	18.60	36.29	27.79
15000 TO 20000	14	PARTS	2.72	4.89	0.00	0.00	0.40	1.51	3.12	4.88
		LABOR	16.49	11.59	2.89	7.37	1.16	3.62	20.54	17.65
		TOTAL	19.21	13.36	2.89	7.37	1.56	4.10	23.66	18.92
GREATER THAN 20000	12	PARTS	2.24	6.03	0.00	0.00	7.58	11.31	9.82	13.16
		LABOR	20.70	16.61	0.67	1.68	8.21	12.07	29.59	20.01
		TOTAL	22.94	21.85	0.67	1.68	15.79	23.09	39.41	32.34

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.50

VEHICLE TUNEUP COST SUMMARY BY MILEAGE
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
1972-1974 MODEL YEAR

MILEAGE	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LESS THAN 20000	21	PARTS	5.79	11.11	0.92	2.15	1.40	3.78	8.11	11.91
		LABOR	24.36	9.96	2.44	5.54	2.96	5.77	29.76	12.44
		TOTAL	30.15	18.46	3.36	7.34	4.36	7.98	37.87	20.42
20000 TO 30000	33	PARTS	4.01	5.73	0.00	0.00	4.15	8.80	8.16	9.14
		LABOR	21.76	10.11	0.41	1.33	5.93	11.53	28.10	9.59
		TOTAL	25.77	12.98	0.41	1.33	10.09	18.65	36.27	16.60
30000 TO 40000	30	PARTS	9.24	13.91	2.37	9.01	3.59	8.05	15.21	20.39
		LABOR	26.73	11.27	1.03	3.34	3.55	5.77	31.32	10.23
		TOTAL	35.97	20.92	3.40	12.11	7.15	13.22	46.53	26.24
40000 TO 50000	21	PARTS	9.86	11.32	0.00	0.00	7.47	11.07	17.33	12.60
		LABOR	23.59	10.75	0.80	2.43	6.24	8.62	30.63	9.38
		TOTAL	33.45	19.23	0.80	2.43	13.71	18.55	47.96	18.55
GREATER THAN 50000	29	PARTS	10.91	11.87	0.13	0.70	0.00	0.00	11.04	12.15
		LABOR	28.68	10.52	0.37	1.35	0.00	0.00	29.05	10.59
		TOTAL	39.59	20.15	0.50	1.60	0.00	0.00	40.09	20.34

VEHICLE TUNEUP COST SUMMARY BY MILEAGE
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
1975-1976 MODEL YEAR

MILEAGE	N		EMISSION RELATED TUNEUP COSTS		MALADJUSTMENT/ DISABLEMENT COSTS		MANUFACTURER RECOMMENDED MAINTENANCE		TOTAL COSTS PER VEHICLE	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LESS THAN 5000	4	PARTS	1.90	3.79	0.00	0.00	0.00	0.00	1.90	3.79
		LABOR	14.85	8.10	1.69	3.37	0.00	0.00	16.54	6.83
		TOTAL	16.75	6.77	1.69	3.37	0.00	0.00	18.43	4.20
5000 TO 10000	27	PARTS	2.47	4.66	0.00	0.00	0.00	0.00	2.47	4.66
		LABOR	21.60	9.96	1.05	2.66	1.10	3.11	23.75	8.85
		TOTAL	24.07	11.32	1.05	2.66	1.10	3.11	26.22	10.64
10000 TO 15000	28	PARTS	1.05	3.33	0.00	0.00	1.67	4.76	2.72	5.67
		LABOR	18.22	7.58	1.21	2.83	2.89	5.85	22.32	7.05
		TOTAL	19.27	8.15	1.21	2.83	4.56	10.26	25.04	10.78
15000 TO 20000	27	PARTS	4.81	10.44	0.31	1.63	0.54	1.56	5.66	10.69
		LABOR	20.00	8.25	0.85	2.83	1.75	4.89	22.60	7.48
		TOTAL	24.81	15.50	1.16	4.35	2.29	6.43	28.26	15.86
GREATER THAN 20000	38	PARTS	3.76	6.60	0.00	0.00	3.32	6.87	7.08	10.82
		LABOR	20.75	7.67	0.11	0.66	6.25	13.47	27.11	9.46
		TOTAL	24.50	10.62	0.11	0.66	9.57	16.85	34.18	18.65

EMISSION CUTPOINTS ARE : 72-74 MODEL YR - CO 5.5% HC 400 PPM
: 75-76 MODEL YR - CO 2.0% HC 250 PPM

TABLE 3.51

VEHICLE TUNE-UP COST SUMMARY BY STRINGENCY FACTOR
ALL PHASE I VEHICLES

1972-1974 MODEL YEARS					1975-1976 MODEL YEARS				
PASS IDLE (N)					PASS IDLE (N)				
Stringency Factor	N		Mean	S.D.	Stringency Factor	N		Mean	S.D.
10	73	Parts	12.57	13.05	10	100	Parts	4.12	8.53
		Labor	29.03	12.31			Labor	21.23	13.87
		Total	41.61	22.48			Total	25.34	20.18
20	66	Parts	11.57	12.71	20	88	Parts	4.04	8.68
		Labor	28.90	12.61			Labor	21.13	14.35
		Total	40.47	22.72			Total	25.16	21.14
30	57	Parts	11.55	12.48	30	78	Parts	4.07	8.85
		Labor	29.27	12.82			Labor	21.32	15.02
		Total	40.82	22.55			Total	25.39	21.98
40	47	Parts	12.33	12.54	40	66	Parts	3.27	7.03
		Labor	29.24	12.60			Labor	21.03	15.03
		Total	41.57	22.13			Total	24.29	20.22
50	41	Parts	13.33	13.02	50	54	Parts	2.92	6.74
		Labor	29.30	12.96			Labor	20.40	14.41
		Total	42.63	23.15			Total	23.32	19.30
FAIL IDLE (N)					FAIL IDLE (N)				
10	9	Parts	26.45	19.11	10	11	Parts	9.90	13.42
		Labor	39.60	12.98			Labor	23.93	11.17
		Total	66.05	22.47			Total	33.83	23.10
20	16	Parts	24.53	16.46	20	23	Parts	7.19	10.89
		Labor	35.52	12.26			Labor	22.89	10.41
		Total	60.05	21.16			Total	30.08	17.87
30	25	Parts	19.91	16.83	30	33	Parts	6.17	10.04
		Labor	32.29	12.59			Labor	21.89	9.65
		Total	52.20	24.57			Total	28.06	16.76
40	35	Parts	16.47	16.41	40	45	Parts	6.78	11.49
		Labor	31.47	13.01			Labor	22.17	11.32
		Total	47.94	25.35			Total	28.95	20.89
50	41	Parts	14.87	15.73	50	57	Parts	6.37	10.86
		Labor	31.08	12.62			Labor	22.52	12.84
		Total	45.95	24.26			Total	28.90	21.45

TABLE 3.52

CORRELATION COEFFICIENTS FOR PERCENT CHANGE IN FTP EMISSIONS
VERSUS COSTS OF MAINTENANCE

	1972-1974				1975-1976			
	HC	CO	NOX	FE	HC	CO	NOX	FE
All Phase I								
Tune-up	0.31*	0.27*	0.21*	0.25*	0.05	0.10	0.08	0.03
Maladj./Disabl.	0.16	0.03	0.26*	0.02	0.10	0.05	0.27*	0.05
Man. Rec. MTCE	0.12	0.18	0.30*	0.18	0.03	0.03	0.02	0.13
Total	0.38*	0.36*	0.32*	0.33*	0.08	0.09	0.12	0.12
Passing Phase I								
Tune-up	0.20	0.22	0.27*	0.25*	0.04	0.28*	0.13	0.13
Maladj./Disabl.	0.11	0.05	0.15	0.14	0.04	0.16	0.43*	0.16
Man. Rec. MTCE	0.17	0.24*	0.26*	0.27*	0.13	0.04	0.05	0.17
Total	0.28*	0.34*	0.38*	0.36*	0.07	0.19	0.18	0.23*
Failing Phases I and II								
Tune-up	0.01	0.03	0.05	0.02	0.06	0.16*	0.02	0.02
Maladj./Disabl.	0.03	0.07	0.19*	0.05	0.11	0.08	0.06	0.17*
Man. Rec. MTCE	0.07	0.05	0.12	0.00	0.10	0.06	0.02	0.02
Total	0.07	0.02	0.07	0.00	0.05	0.07	0.02	0.03

*Significantly non-zero at 95 percent level of confidence.

TABLE 3.53

STANDARD DEVIATIONS OF REPLICATE SHORT TEST VALUES - ALL PHASE I VEHICLES

	ALL VEHICLES				THREE VEHICLES ELIMINATED	
	1972-1974		1975-1976		1975-1976	
	S.D.	C.V.*	S.D.	C.V.*	S.D.	C.V.*
HC						
Hot FTP	0.28	5.8	0.39	19.3	0.40	19.1
Fed. Short Cycle	0.49	10.2	0.62	39.6	0.63	39.0
Fed. Three Mode(50)	27.3	15.0	11.7	13.3	11.8	13.1
Fed. Three Mode(30)	26.8	10.8	19.0	18.4	19.2	18.2
Fed. Three Mode(N)	97.7	30.7	63.8	35.9	64.7	35.5
Idle (2250)	35.0	17.7	36.4	50.9	36.9	50.3
Idle (N)	78.8	26.8	134.6	100.4	39.7	31.0
CO						
Hot FTP	4.98	6.6	7.48	16.4	7.58	16.2
Fed. Short Cycle	5.84	10.5	7.90	26.4	8.01	26.1
Fed. Three Mode(50)	0.34	13.2	0.38	18.1	0.39	17.8
Fed. Three Mode(30)	0.24	10.0	0.72	37.8	0.73	37.3
Fed. Three Mode(N)	0.42	9.1	0.65	25.4	0.66	25.1
Idle (2250)	0.49	20.4	0.97	66.7	0.99	65.9
Idle (N)	0.44	10.7	0.86	43.6	0.59	30.1
NOX						
Hot FTP	0.11	5.0	0.12	7.0	0.12	6.9
Fed. Short Cycle	0.12	6.6	0.09	6.7	0.10	6.5
Fed. Three Mode(50)	308	22	132	13.3	134	13.1
Fed. Three Mode(30)	276	28.6	98	16.6	100	16.4
Fed. Three Mode(N)	11.5	20.9	8.3	16.3	8.4	16.1
Idle (2250)	62.4	28.8	49.7	35.2	50.3	34.6
Idle (N)	7.1	13.3	10.9	20.3	10.2	22.2

* C.V. = Coefficient of Variation = 100(S.D./Avg)

TABLE 3.54

STANDARD DEVIATIONS OF REPLICATE SHORT TEST VALUES - PASSING PHASE I AND FAILING PHASES I AND II

	PASSING PHASE I				FAILING PHASES I AND II			
	1972-1974		1975-1976		1972-1974		1975-1976	
	S.D.	C.V.*	S.D.	C.V.*	S.D.	C.V.*	S.D.	C.V.*
HC								
Hot FTP	0.28	6.6	0.44	28.9	0.37	6.2	0.24	7.3
Fed. Short Cycle	0.49	13.5	0.77	69.1	0.32	6.5	0.54	19.1
Fed. Three Mode(50)	33.5	35.9	13.3	17.0	15.2	7.4	21.5	19.2
Fed. Three Mode(30)	24.0	11.1	19.6	22.8	39.1	13.3	20.2	14.3
Fed. Three Mode(N)	63.4	33.6	29.0	25.7	98.7	17.7	77.1	22.3
Idle (2250)	28.9	21.1	33.8	70.3	112.1	37.0	59.6	46.7
Idle (N)	26.3	16.6	34.4	60.0	145.8	27.1	73.2	27.4
CO								
Hot FTP	4.65	6.9	7.63	23.0	4.62	5.3	5.97	8.0
Fed. Short Cycle	6.66	13.2	8.39	41.9	5.41	8.6	6.83	12.3
Fed. Three Mode(50)	0.35	14.7	0.34	18.9	0.42	13.1	0.48	18.8
Fed. Three Mode(30)	0.25	11.5	0.78	50.3	0.39	13.8	0.58	22.1
Fed. Three Mode(N)	0.43	14.9	0.23	20.2	0.67	10.1	0.78	14.0
Idle (2250)	0.54	28.8	1.02	122.6	0.60	18.7	0.84	29.1
Idle (N)	0.45	18.5	0.43	75.0	0.60	9.7	0.73	14.9
NOX								
Hot FTP	0.11	4.9	0.13	7.2	0.12	6.2	0.11	7.2
Fed. Short Cycle	0.14	7.8	0.10	7.3	0.12	7.1	0.16	11.9
Fed. Three Mode(50)	337	25.1	136	13.6	237	18.7	160	16.7
Fed. Three Mode(30)	307	33.6	87	15.6	182	20.7	182	30.3
Fed. Three Mode(N)	14.0	23.2	9.4	17.3	25.0	54.8	4.8	11.8
Idle (2250)	50.0	25.8	29.2	23.9	71.4	36.0	51.0	32.9
Idle (N)	7.6	13.5	9.3	16.9	8.3	18.4	10.2	22.2

* C.V. = Coefficient of Variation = 100(S.D./Avg)

TABLE 3.55

STUDENT'S t STATISTICS** FOR EVALUATING SIGNIFICANCE OF AVERAGE DIFFERENCE OF REPLICATE DETERMINATIONS - ALL PHASE I

	MODEL YEAR	
	1972-1974	1975-1976
HC		
Hot FTP	1.37	-0.22
Fed. Short Cycle	-0.41	1.46
Fed. Three Mode (50)	0.36	2.08*
Fed. Three Mode (30)	-0.23	0.03
Fed. Three Mode (N)	-1.52	-0.64
Idle (2250)	-0.61	-2.03*
Idle (N)	-2.28*	-1.41
CO		
Hot FTP	-1.12	0.96
Fed. Short Cycle	0.92	2.28*
Fed. Three Mode (50)	-1.74	1.36
Fed. Three Mode (30)	-2.66*	-0.64
Fed. Three Mode (N)	0.64	-1.30
Idle (2250)	-3.49*	-2.16*
Idle (N)	-2.48*	-2.31*
NOX		
Hot FTP	-1.26	-2.40*
Fed. Short Cycle	-1.11	-1.53
Fed. Three Mode (50)	0.89	-2.29*
Fed. Three Mode (30)	-0.41	-1.86
Fed. Three Mode (N)	-1.23	0.04
Idle (2250)	-0.17	-0.36
Idle (N)	-0.53	0.64

* Significant at 95% level of confidence.

** Negative value implies second determination was larger.

TABLE 3.56

REGRESSION EQUATIONS FOR PREDICTING PRE-MAINTENANCE FTP EMISSIONS AS A FUNCTION OF PRE-MAINTENANCE SHORT TEST EMISSIONS - ALL PHASE I VEHICLES

	Model Year	Short Test	Regression Equation*	r	s(e)
HC	1972-1974	Hot FTP	$y = 0.22 + 1.06x$	0.93	1.41
		Fed. Short Cycle	$= 0.46 + 1.23x$	0.89	1.66
		Fed. Three Mode	$= 2.15+0.0094x_1+0.0038x_2+0.0018x_3$	0.88	1.79
		Idle	$= 3.32 + 0.0022x_1 + 0.0057x_2$	0.63	2.92
		Idle (N)	$= 3.40 + 0.0069x$	0.60	2.98
	1975-1976	Hot FTP	$y = 0.48 + 0.901x$	0.93	0.52
		Fed. Short Cycle	$= 0.95 + 0.826x$	0.84	0.79
		Fed. Three Mode	$= 0.99+0.0059x_1+0.0048x_2+0.0017x_3$	0.60	1.16
		Idle	$= 1.42 + 0.0059x_1 + 0.0044x_2$	0.61	1.15
		Idle (N)	$= 1.68 + 0.00527x$	0.55	1.20
CO	1972-1974	Hot FTP	$y = 4.46 + 1.06x$	0.96	10.73
		Fed. Short Cycle	$= 20.46 + 1.11x$	0.89	16.90
		Fed. Three Mode	$= 33.66+5.69x_1+8.33x_2+3.40x_3$	0.65	29.18
		Idle	$= 57.20 + 4.73x_1 + 3.77x_2$	0.44	34.04
		Idle (N)	$= 62.19 + 5.14x$	0.41	34.49
	1975-1976	Hot FTP	$y = 8.23 + 0.912x$	0.96	10.49
		Fed. Short Cycle	$= 20.16 + 0.964x$	0.86	19.25
		Fed. Three Mode	$= 15.95+7.04x_1+1.93x_2+6.38x_3$	0.76	25.08
		Idle	$= 25.50 + 7.24x_1 + 8.97x_2$	0.76	24.87
		Idle (N)	$= 28.42 + 12.28x$	0.71	26.76
NOX	1972-1974	Hot FTP	$y = 0.10 + 0.95x$	0.99	0.20
		Fed. Short Cycle	$= 0.33 + 1.04x$	0.94	0.40
		Fed. Three Mode	$= 0.64+0.00044x_1+0.00086x_2+0.00144x_3$	0.75	0.59
		Idle	$= 1.07 + 0.00344x_1 + 0.00652x_2$	0.58	0.95
		Idle (N)	$= 1.14 + 0.0192x_1$	0.32	1.10
	1975-1976	Hot FTP	$y = 0.18 + 0.926x$	0.98	0.16
		Fed. Short Cycle	$= 0.54 + 0.831x$	0.87	0.42
		Fed. Three Mode	$= 0.76+0.00051x_1+0.00083x_2-0.00063x_3$	0.74	0.58
		Idle	$= 1.19 + 0.00400x_1 - 0.00109x_2$	0.55	0.72
		Idle (N)	$= 1.37 + 0.00621x$	0.19	0.85

* For Fed. Three Mode, x_1, x_2, x_3 refer to 50, 30, and N modes, respectively. For Idle, x_1 and x_2 refer to Idle (2250) and Idle (N), respectively.

TABLE 3.57

REGRESSION EQUATION FOR PREDICTING PRE-MAINTENANCE FTP EMISSIONS AS A FUNCTION OF PRE-MAINTENANCE SHORT TEST EMISSIONS PASSING PHASE I VEHICLES

	Model Year	Short Test	Regression Equation *	r	s(e)
HC	1972-1974	Hot FTP	$y = 0.41 + 1.01x$	0.61	1.74
		Fed. Short Cycle	$= 1.76 + 0.822x$	0.48	1.94
		Fed. Three Mode	$= 2.09+0.1784x_1+0.00315x_2-0.00469x_3$	0.66	1.70
		Idle	$= 4.41 - 0.00029x_1 + 0.00223x_2$	0.07**	2.22
		Idle (N)	$= 4.40 + 0.00200x$	0.07**	2.20
	1975-1976	Hot FTP	$y = 0.42 + 0.893x$	0.78	0.53
		Fed. Short Cycle	$= 1.16 + 0.477x$	0.68	0.62
		Fed. Three Mode	$= 1.13+0.00251x_1+0.00432x_2+0.00031x_3$	0.45	0.76
		Idle	$= 1.06 + 0.00513x_1 + 0.00875x_2$	0.53	0.72
		Idle (N)	$= 1.20 + 0.01005x$	0.47	0.57
CO	1972-1974	Hot FTP	$y = 3.32 + 1.07x$	0.92	11.52
		Fed. Short Cycle	$= 26.35 + 0.948x$	0.84	16.44
		Fed. Three Mode	$= 40.52+5.34x_1+7.76x_2+1.93x_3$	0.66	22.80
		Idle	$= 64.71 + 5.69x_1 + 0.176x_2$	0.27	29.10
		Idle (N)	$= 70.22 + 1.93x$	0.10**	29.72
	1975-1976	Hot FTP	$y = 9.80 + 0.809x$	0.87	9.72
		Fed. Short Cycle	$= 22.31 + 0.678x$	0.64	15.25
		Fed. Three Mode	$= 22.57+3.64x_1+4.26x_2+0.954x_3$	0.56	16.72
		Idle	$= 24.43 + 10.37x_1 + 11.08x_2$	0.69	14.50
		Idle (N)	$= 28.48 + 15.97x$	0.51	17.03
NOX	1972-1974	Hot FTP	$y = 0.14 + 0.935x$	0.99	0.19
		Fed. Short Cycle	$= 0.37 + 1.06x$	0.93	0.42
		Fed. Three Mode	$= 0.91+0.00048x_1+0.00068x_2+0.00064x_3$	0.72	0.84
		Idle	$= 1.12 + 0.00412x_1 + 0.00553x_2$	0.61	0.94
		Idle (N)	$= 0.98 + 0.222x$	0.36	1.10
	1975-1976	Hot FTP	$y = 0.18 + 0.929x$	0.98	0.16
		Fed. Short Cycle	$= 0.44 + 0.962x$	0.90	0.41
		Fed. Three Mode	$= 0.67+0.00056x_1+0.00129x_2+0.00257x_3$	0.82	0.55
		Idle	$= 1.26 + 0.00843x_1 - 0.00936x_2$	0.67	0.70
		Idle (N)	$= 1.59 + 0.00291x$	0.08**	0.94

* For Federal Three Mode, x_1, x_2, x_3 refer to 50, 30, and N modes, respectively. For Idle, x_1 and x_2 refer to Idle (2250) and (N), respectively.

** Not significantly different from zero.

TABLE 3.58

REGRESSION EQUATIONS FOR PREDICTING PRE-MAINTENANCE FTP EMISSIONS AS A FUNCTION OF PRE-MAINTENANCE SHORT TEST EMISSIONS - FAILING PHASES I AND II VEHICLES

	Model Year	Short Test	Regression Equation *	r	s(e)
HC	1972-1974	Hot FTP	$y = 0.18 + 1.07x$	0.95	1.12
		Fed. Short Cycle	$= 1.03 + 1.08x$	0.89	0.68
		Fed. Three Mode	$= 1.98+0.00267x_1+0.007804x_2+0.00300x_3$	0.79	2.25
		Idle	$= 4.02 + 0.00054x_1 + 0.00441x_2$	0.58	2.98
		Idle (N)	$= 4.06 + 0.00463x$	0.58	2.98
	1975-1976	Hot FTP	$y = 0.34 + 1.01x$	0.97	0.54
		Fed. Short Cycle	$= 0.25 + 1.20x$	0.92	0.84
		Fed. Three Mode	$= 1.75+0.00559x_1+0.00586x_2+0.00112x_3$	0.72	1.47
		Idle	$= 2.20 + 0.00308x_1 + 0.00408x_2$	0.44	1.89
		Idle (N)	$= 2.41 + 0.00460x$	0.41	1.91
CO	1972-1974	Hot FTP	$y = 5.73 + 1.02x$	0.97	8.53
		Fed. Short Cycle	$= 22.63 + 1.10x$	0.91	15.45
		Fed. Three Mode	$= 53.28+0.101x_1+7.41x_2+2.99x_3$	0.49	32.76
		Idle	$= 61.29 + 2.56x_1 + 4.01x_2$	0.38	34.65
		Idle (N)	$= 65.15 + 4.63x$	0.36	34.82
	1975-1976	Hot FTP	$y = 8.67 + 0.956x$	0.96	10.72
		Fed. Short Cycle	$= 22.73 + 1.02z$	0.88	19.16
		Fed. Three Mode	$= 31.79+6.33x_1+0.963x_2+5.44x_3$	0.63	31.50
		Idle	$= 33.45 + 4.28x_1 + 7.45x_2$	0.61	32.01
		Idle (N)	$= 35.42 + 9.31x$	0.58	32.82
NOX	1972-1974	Hot FTP	$y = 0.07 + 0.981x$	0.97	0.25
		Fed. Short Cycle	$= 0.35 + 0.986x$	0.91	0.43
		Fed. Three Mode	$= 0.82+0.00051x_1+0.00060x_2+0.00049x_3$	0.67	0.74
		Idle	$= 1.37 + 0.00372x_1 + 0.00234x_2$	0.56	0.84
		Idle (N)	$= 1.64 + 0.00793x$	0.16	1.00
	1975-1976	Hot FTP	$y = 0.17 + 0.929x$	0.96	0.17
		Fed. Short Cycle	$= 0.66 + 0.676x$	0.80	0.38
		Fed. Three Mode	$= 0.83+0.00041x_1+0.00018x_2+0.00488x_3$	0.62	0.50
		Idle	$= 0.99 + 0.00189x_1 + 0.00475x_2$	0.48	0.55
		Idle (N)	$= 1.12 + 0.00809x$	0.32	0.59

* For Federal Three Mode, x_1, x_2, x_3 refer to 50, 30, and N modes, respectively. For Idle, x_1 and x_2 refer to Idle (2250) and (N), respectively.

TABLE 3.59

REGRESSION EQUATIONS FOR 1975 FTP EMISSIONS AS A FUNCTION OF SHORT TEST EMISSIONS - LOW ALTITUDE DATA

	Model Year	Short Test	Regression Equation*	r
HC	1975	Fed. Short Cycle	$y = 0.53 + 0.839x$	0.78
		Fed. Three Mode	$= 0.55+0.0030x_1+0.0071x_2 +0.0022x_3$	0.58
		Idle (N)	$= 0.99 + 0.0025x$	0.42
CO	1975	Fed. Short Cycle	$y = 7.64 + 1.08x$	0.89
		Fed. Three Mode	$= 10.07+6.93x_1+11.09x_2+2.85x_3$	0.73
		Idle (N)	$12.86 + 6.99x$	0.64
NOX	1975	Fed. Short Cycle	$y = 0.79 + 0.893x$	0.81
		Fed. Three Mode	$= 1.13+0.0034x_1+0.0004x_2 +0.0005x_3$	0.59

* For Federal Three Mode, x_1, x_2, x_3 refer to 50, 30, and N modes, respectively.

TABLE 3.60

PARTIAL CORRELATION COEFFICIENTS OF MILEAGE TERM IN PREDICTING FTP EMISSION FROM SHORT TEST EMISSIONS AND MILEAGE

	ALL PHASE I			PASSING PHASE I			FAILING PHASES I AND II		
	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1972-1974									
Hot FTP	0.07	0.06	-0.05	0.04	0.08	-0.00	0.02	0.06	-0.01
Fed. Short Cycle	0.05	0.04	0.02	-0.03	-0.04	0.11	0.04	0.14	-0.03
Fed. Three Mode	0.12	0.14	-0.10	0.13	0.04	0.01	0.06	0.05	0.03
Idle	0.09	0.16	-0.07	-0.06	0.09	-0.09	0.11	0.12	0.01
Idle (N)	0.09	0.16	-0.01	-0.06	0.06	0.06	0.11	0.12	0.01
1975-1976									
Hot FTP	-0.10	-0.12	0.16	-0.12	-0.05	0.19	0.02	-0.03	0.08
Fed. Short Cycle	0.07	-0.01	0.15	0.14	0.19	0.25	-0.13	-0.08	0.13
Fed. Three Mode	0.17	0.20	0.11	0.09	0.25	0.25	0.22	0.23	0.15
Idle	0.13	0.15	0.08	-0.01	0.23	0.15	0.15	0.21	0.16
Idle (N)	0.11	0.08	0.07	-0.05	0.16	0.10	0.14	0.18	0.15

TABLE 3.61

SHORT TEST CUTPOINTS FOR INDIVIDUAL EMITTANTS AT STRINGENCY FACTORS OF 10%, 20%, 30%, 40%, 50%

STRINGENCY FACTOR	10%		20%		30%		40%		50%	
MODEL YEAR	72-74	75-76	72-74	75-76	72-74	75-76	72-74	75-76	72-74	75-76
HC										
Hot FTP	7.04	3.32	5.30	2.75	4.98	2.40	4.64	2.13	4.45	1.81
Fed. Short Cycle	5.64	2.81	4.83	2.23	4.05	1.96	3.80	1.60	3.54	1.36
Fed. 3 Mode (50 mph)	274.	169.	199.	144.	179.	119.	169.	104.	149.	79.
Fed. 3 Mode (30 mph)	339.	194.	299.	164.	249.	134.	239.	124.	219.	89.
Fed. 3 Mode (N)	649.	389.	389.	239.	309.	204.	269.	154.	239.	109.
Idle 2250	319.	159.	179.	104.	129.	64.	119.	54.	99.	39.
Idle (N)	639.	249.	339.	189.	259.	149.	219.	89.	209.	69.
CO										
Hot FTP	119.43	89.06	99.00	66.47	81.30	54.30	74.04	46.31	65.29	39.02
Fed. Short Cycle	103.84	66.36	81.80	46.19	62.66	36.46	57.82	29.40	46.47	22.49
Fed. 3 Mode (50 mph)	4.99	4.79	3.79	3.69	3.29	2.89	2.39	2.29	2.19	1.49
Fed. 3 Mode (30 mph)	4.19	4.19	3.49	3.09	2.69	2.19	2.49	1.89	1.99	1.59
Fed. 3 Mode (N)	9.19	7.39	7.99	4.59	6.59	3.29	5.59	2.69	4.19	1.44
Idle 2250	4.69	3.49	3.79	2.09	3.09	1.39	2.29	0.79	1.69	0.54
Idle (N)	8.39	4.79	7.39	3.49	5.99	2.29	4.59	1.64	3.29	0.99
NOX										
Hot FTP	3.92	2.46	3.02	2.15	2.57	1.99	2.11	1.77	1.81	1.56
Fed. Short Cycle	3.44	2.43	2.46	1.96	2.12	1.73	1.77	1.46	1.54	1.15
Fed. 3 Mode (50 mph)	2787.	2065.	2189.	1343.	1741.	1045.	1518.	945.	1393.	829.
Fed. 3 Mode (30 mph)	1741.	1368.	1468.	920.	1149.	675.	1120.	563.	900.	429.
Fed. 3 Mode (N)	79.	80.	69.	69.	61.	58.	56.	52.	50.	44.
Idle 2250	470.	327.	286.	212.	222.	154.	201.	123.	164.	100.
Idle (N)	78.	86.	71.	74.	64.	68.	58.	60.	54.	51.

TABLE 3.62

ERRORS OF OMISSION AND COMMISSION

IDLE (NEUTRAL)
ALL PHASE I VEHICLES
1972-1974 MODEL YEAR VEHICLES
FOR HC ONLY

ASSUMED FAILURE RATE (%)	CUTPOINTS HC	SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
10.	639.00	9.8	85.4	0.0
20.	339.00	20.7	74.4	0.0
30.	259.00	30.5	65.9	1.2
40.	219.00	46.3	50.0	1.2
50.	209.00	50.0	46.3	1.2

FOR CO ONLY

ASSUMED FAILURE RATE (%)	CUTPOINTS CO	SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
10.	8.39	11.0	87.8	0.0
20.	7.39	19.5	79.3	0.0
30.	5.99	30.5	68.3	0.0
40.	4.59	40.2	58.5	0.0
50.	3.29	50.0	48.8	0.0

FOR NOX ONLY

ASSUMED FAILURE RATE (%)	CUTPOINTS NOX	SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
10.	78.19	9.8	14.6	7.3
20.	71.09	20.7	12.2	15.9
30.	64.09	31.7	9.8	24.4
40.	58.09	40.2	8.5	31.7
50.	54.09	51.2	4.9	39.0

FOR HC, CO, AND NOX COMBINED

ASSUMED FAILURE RATE (%)	----------CUTPOINTS---------- HC	CO	NOX	SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
10.	739.00	9.99	99999.00	11.0	89.0	0.0
20.	599.00	8.19	99999.00	19.5	80.5	0.0
30.	599.00	6.29	99999.00	30.5	69.5	0.0
40.	389.00	5.39	99999.00	42.7	57.3	0.0
50.	314.00	4.29	111.09	50.0	50.0	0.0

VALUES OF 99999.00 INDICATE NO CUTPOINT NEEDED FOR THAT POLLUTANT.

TABLE 3.63

ERRORS OF OMISSION AND COMMISSION

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
FOR HC ONLY

ASSUMED FAILURE RATE (%)	CUTPOINTS HC	SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
10.	249.00	10.8	56.8	0.0
20.	189.00	21.6	45.9	0.0
30.	149.00	29.7	37.8	0.0
40.	89.00	40.5	27.9	0.9
50.	69.00	51.4	19.8	3.6

FOR CO ONLY

ASSUMED FAILURE RATE (%)	CUTPOINTS CO	SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
10.	4.79	9.9	80.2	0.0
20.	3.49	19.8	70.3	0.0
30.	2.29	30.6	59.5	0.0
40.	1.64	39.6	50.5	0.0
50.	0.99	50.5	39.6	0.0

FOR NOX ONLY

ASSUMED FAILURE RATE (%)	CUTPOINTS NOX	SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
10.	86.19	9.9	2.7	8.1
20.	74.19	19.8	0.9	16.2
30.	68.09	29.7	0.9	26.1
40.	60.09	40.5	0.9	36.9
50.	51.09	51.4	0.9	47.7

FOR HC, CO, AND NOX COMBINED

ASSUMED FAILURE RATE (%)	----------CUTPOINTS----------			SAMPLE FAILURE RATE (%)	ERRORS OF OMISSION (%)	ERRORS OF COMMISSION (%)
	HC	CO	NOX			
10.	1199.00	5.59	99999.00	9.9	82.9	0.0
20.	1199.00	3.49	99999.00	20.7	72.1	0.0
30.	1199.00	2.39	99999.00	29.7	63.1	0.0
40.	394.00	1.69	99999.00	40.5	52.3	0.0
50.	299.00	0.99	99999.00	51.4	41.4	0.0

VALUES OF 99999.00 INDICATE NO CUTPOINT NEEDED FOR THAT POLLUTANT.

TABLE 3.64

I/M IMPACT MEASURE* FOR STRINGENCY FACTORS OF 10%, 20%, 30%, 40%, AND 50% IDLE (N) SHORT TEST

Model Year	Stringency Factor	HC	CO	NOX	Composite
1972-1974	10	0.32	0.16	0.09	0.22
	20	0.43	0.30	0.09	0.34
	30	0.51	0.41	0.10	0.44
	40	0.60	0.53	0.30	0.55
	50	0.65	0.61	0.58	0.62
1975-1976	10	0.27	0.23	0	0.24
	20	0.49	0.42	0	0.43
	30	0.64	0.54	0	0.55
	40	0.78	0.67	0.16	0.69
	50	0.87	0.76	0.24	0.78

TABLE 3.65

I/M IMPACT MEASURE* FOR STRINGENCY FACTORS OF 10%, 20%, 30%, 40%, AND 50% FEDERAL SHORT CYCLE SHORT TEST

Model Year	Stringency Factor	HC	CO	NOX	Composite
1972-1974	10	0.35	0.26	0	0.28
	20	0.44	0.41	0	0.41
	30	0.60	0.56	0.16	0.56
	40	0.67	0.66	0.20	0.65
	50	0.73	0.73	0.50	0.72
1975-1976	10	0.32	0.27	0	0.28
	20	0.47	0.44	0	0.44
	30	0.64	0.59	0	0.60
	40	0.72	0.68	0	0.69
	50	0.81	0.79	0.19	0.79

* Contribution

TABLE 3.66

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IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN 1975 FTP HC EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	4.81	2.03
20.	66	4.67	2.00
30.	57	4.66	2.13
40.	47	4.66	2.28
50.	41	4.63	2.44

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	10.13	8.55
20.	16	8.36	6.70
30.	25	7.06	5.60
40.	35	6.38	4.88
50.	41	6.15	4.54

TABLE 3.67

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN 1975 FTP HC EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	0.82	0.24
20.	8	0.82	0.24
30.	8	0.82	0.24
40.	8	0.82	0.24
50.	8	0.82	0.24

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	2.22	1.09
20.	80	2.06	0.95
30.	70	1.91	0.82
40.	58	1.74	0.75
50.	46	1.63	0.71

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	4.12	2.51
20.	23	3.70	1.99
30.	33	3.53	1.77
40.	45	3.31	1.59
50.	57	3.07	1.53

TABLE 3.68

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN 1975 FTP CO EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	80.33	35.22
20.	66	76.85	31.81
30.	57	75.28	30.69
40.	47	74.07	29.83
50.	41	72.65	30.61

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	104.98	49.87
20.	16	108.54	48.55
30.	25	100.71	45.69
40.	35	95.07	43.48
50.	41	93.41	41.16

TABLE 3.69

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN 1975 FTP CO EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	10.85	2.55
20.	8	10.85	2.55
30.	8	10.85	2.55
40.	8	10.85	2.55
50.	8	10.85	2.55

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	48.04	25.80
20.	80	43.36	20.30
30.	70	41.06	18.91
40.	58	37.05	15.40
50.	46	35.60	15.87

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	97.32	77.29
20.	23	87.89	58.85
30.	33	79.29	52.06
40.	45	74.26	46.61
50.	57	67.60	43.67

TABLE 3.70

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN 1975 FTP NOX EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN ,	SD
10.	73	2.19	1.16
20.	66	2.21	1.19
30.	57	2.27	1.25
40.	47	2.27	1.21
50.	41	2.12	1.09

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	2.06	1.11
20.	16	2.03	0.98
30.	25	1.94	0.85
40.	35	2.04	1.08
50.	41	2.22	1.22

TABLE 3.71

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN 1975 FTP NOX EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	2.06	0.46
20.	8	2.06	0.46
30.	8	2.06	0.46
40.	8	2.06	0.46
50.	8	2.06	0.46

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	1.70	0.89
20.	80	1.71	0.94
30.	70	1.73	0.99
40.	58	1.72	1.02
50.	46	1.72	1.05

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	1.56	0.78
20.	23	1.63	0.63
30.	33	1.59	0.58
40.	45	1.65	0.67
50.	57	1.67	0.72

TABLE 3.72

FEDERAL SHORT CYCLE
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN 1975 FTP HC EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	74	4.73	1.81
20.	66	4.66	1.87
30.	57	4.37	1.17
40.	49	4.28	1.14
50.	41	4.30	1.12

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	8	11.54	8.74
20.	16	8.42	6.82
30.	25	7.73	5.90
40.	33	7.04	5.29
50.	41	6.49	4.90

TABLE 3.73

FEDERAL SHORT CYCLE
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN 1975 FTP HC EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	0.82	0.24
20.	8	0.82	0.24
30.	8	0.82	0.24
40.	8	0.82	0.24
50.	8	0.82	0.24

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	2.17	0.96
20.	81	2.07	0.90
30.	70	1.91	0.78
40.	59	1.83	0.79
50.	47	1.75	0.80

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	4.54	2.59
20.	22	3.72	2.13
30.	33	3.53	1.81
40.	44	3.22	1.68
50.	56	2.99	1.58

TABLE 3.74

FEDERAL SHORT CYCLE
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN 1975 FTP CO EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	74	74.38	25.61
20.	66	69.90	22.06
30.	57	65.06	16.58
40.	49	62.31	15.06
50.	41	60.67	13.83

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	8	163.06	36.69
20.	16	137.19	40.10
30.	25	124.00	39.95
40.	33	113.81	39.87
50.	41	105.39	40.44

TABLE 3.75

FEDERAL SHORT CYCLE
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN 1975 FTP CO EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	10.85	2.55
20.	8	10.85	2.55
30.	8	10.85	2.55
40.	8	10.85	2.55
50.	8	10.85	2.55

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	46.19	22.41
20.	81	42.24	19.85
30.	70	37.76	15.54
40.	59	35.87	15.62
50.	47	32.07	14.15

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	112.85	74.03
20.	22	94.06	56.14
30.	33	86.29	48.31
40.	44	76.69	45.25
50.	56	71.13	41.78

TABLE 3.76

FEDERAL SHORT CYCLE
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN 1975 FTP NOX EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	74	2.26	1.18
20.	66	2.31	1.22
30.	57	2.31	1.18
40.	49	2.45	1.18
50.	41	2.38	1.03

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	8	1.39	0.34
20.	16	1.60	0.48
30.	25	1.86	1.03
40.	33	1.76	0.98
50.	41	1.96	1.24

TABLE 3.77

FEDERAL SHORT CYCLE
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN 1975 FTP NOX EMISSIONS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	2.06	0.46
20.	8	2.06	0.46
30.	8	2.06	0.46
40.	8	2.06	0.46
50.	8	2.06	0.46

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	1.76	0.90
20.	81	1.80	0.94
30.	70	1.86	0.99
40.	59	1.88	1.04
50.	47	1.91	1.08

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	1.08	0.31
20.	22	1.27	0.35
30.	33	1.33	0.42
40.	44	1.43	0.51
50.	56	1.50	0.62

TABLE 3.78

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN COLD TRANSIENT HC EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	24.48	24.87
20.	66	24.21	26.01
30.	57	24.75	27.89
40.	47	25.23	30.66
50.	41	25.74	32.80

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	40.98	31.93
20.	16	34.85	25.10
30.	25	29.79	21.28
40.	35	27.71	18.40
50.	41	26.83	17.19

TABLE 3.79

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN COLD TRANSIENT HC EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	8.10	3.35
20.	8	8.10	3.35
30.	8	8.10	3.35
40.	8	8.10	3.35
50.	8	8.10	3.35

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	12.62	6.39
20.	80	12.03	6.13
30.	70	11.26	4.57
40.	58	10.86	4.67
50.	46	10.61	4.18

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	19.38	10.99
20.	23	17.89	9.01
30.	33	17.76	9.65
40.	45	16.54	8.67
50.	57	15.54	8.42

TABLE 3.80

IDLE (NEUTRAL)
ALL PHASE I VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN COLD TRANSIENT CO EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	367.01	189.09
20.	66	357.72	187.76
30.	57	364.16	195.60
40.	47	369.56	209.08
50.	41	368.20	220.46

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	423.35	170.33
20.	16	437.03	175.00
30.	25	393.81	167.59
40.	35	378.08	155.25
50.	41	378.20	148.80

TABLE 3.81

IDLE (NEUTRAL)
ALL PHASE I VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN COLD TRANSIENT CO EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	140.94	41.86
20.	8	140.94	41.86
30.	8	140.94	41.86
40.	8	140.94	41.86
50.	8	140.94	41.86

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	249.88	116.70
20.	80	233.26	100.57
30.	70	225.43	93.41
40.	58	212.90	88.96
50.	46	211.10	88.04

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	376.94	298.97
20.	23	368.46	230.24
30.	33	344.09	207.21
40.	45	328.60	184.73
50.	57	305.70	175.01

TABLE 3.82

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN COLD TRANSIENT NOX EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	9.57	5.21
20.	66	9.61	5.33
30.	57	9.80	5.62
40.	47	9.67	5.45
50.	41	9.00	4.94

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	9.07	4.38
20.	16	9.09	4.16
30.	25	8.84	3.70
40.	35	9.29	4.67
50.	41	10.03	5.28

TABLE 3.83

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN COLD TRANSIENT NOX EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	7.99	1.72
20.	8	7.99	1.72
30.	8	7.99	1.72
40.	8	7.99	1.72
50.	8	7.99	1.72

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	7.57	3.21
20.	80	7.60	3.32
30.	70	7.65	3.41
40.	58	7.69	3.61
50.	46	7.68	3.80

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	7.36	3.76
20.	23	7.33	3.07
30.	33	7.31	2.92
40.	45	7.36	2.76
50.	57	7.44	2.76

TABLE 3.84

IDLE (NEUTRAL)
ALL PHASE I VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN COLD STABILIZED HC EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	16.45	5.70
20.	66	15.78	4.98
30.	57	15.42	5.10
40.	47	15.16	5.15
50.	41	14.92	5.40

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	40.53	33.91
20.	16	32.72	26.93
30.	25	27.45	22.56
40.	35	24.36	19.75
50.	41	23.26	18.44

TABLE 3.85

IDLE (NEUTRAL)
ALL PHASE I VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN COLD STABILIZED HC EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	1.34	0.54
20.	8	1.34	0.54
30.	8	1.34	0.54
40.	8	1.34	0.54
50.	8	1.34	0.54

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	6.89	4.31
20.	80	6.14	3.74
30.	70	5.54	3.39
40.	58	4.66	2.77
50.	46	4.10	2.51

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	15.34	8.20
20.	23	13.54	6.68
30.	33	12.59	6.01
40.	45	11.84	5.48
50.	57	10.78	5.42

TABLE 3.86

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN COLD STABILIZED CO EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	301.76	144.76
20.	66	284.45	123.73
30.	57	271.54	111.92
40.	47	261.19	102.70
50.	41	251.93	100.27

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	421.02	223.71
20.	16	440.28	218.35
30.	25	413.60	201.14
40.	35	386.92	189.48
50.	41	377.77	180.02

TABLE 3.87

IDLE (NEUTRAL)
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN COLD STABILIZED CO EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	4.74	5.42
20.	8	4.74	5.42
30.	8	4.74	5.42
40.	8	4.74	5.42
50.	8	4.74	5.42

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	160.46	105.51
20.	80	140.93	88.28
30.	70	131.03	84.94
40.	58	111.49	66.68
50.	46	103.07	69.60

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	409.11	291.31
20.	23	347.32	222.84
30.	33	305.78	200.50
40.	45	284.37	182.06
50.	57	254.76	172.45

TABLE 3.88

IDLE (NEUTRAL)
ALL PHASE I VEHICLES
1972-1974 MODEL YEAR VEHICLES
MEAN COLD STABILIZED NOX EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	73	6.60	3.45
20.	66	6.68	3.53
30.	57	6.94	3.69
40.	47	6.94	3.44
50.	41	6.52	3.12

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	9	6.10	3.60
20.	16	5.98	3.12
30.	25	5.65	2.70
40.	35	6.02	3.44
50.	41	6.58	3.79

TABLE 3.89

IDLE (NEUTRAL)
ALL PHASE I VEHICLES
1975-1976 MODEL YEAR VEHICLES
MEAN COLD STABILIZED NOX EMISSIONS IN GRAMS
FAILURE RATE ON HC , CO , AND NOX

PASS SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	8	7.52	2.00
20.	8	7.52	2.00
30.	8	7.52	2.00
40.	8	7.52	2.00
50.	8	7.52	2.00

PASS SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	92	5.33	3.55
20.	80	5.33	3.76
30.	70	5.43	3.95
40.	58	5.29	3.96
50.	46	5.37	4.21

FAIL SHORT TEST , PASS FTP

FAILURE RATE	N	MEAN	SD
10.	0	0.00	0.00
20.	0	0.00	0.00
30.	0	0.00	0.00
40.	0	0.00	0.00
50.	0	0.00	0.00

FAIL SHORT TEST , FAIL FTP

FAILURE RATE	N	MEAN	SD
10.	11	4.53	2.43
20.	23	4.94	2.05
30.	33	4.84	2.00
40.	45	5.18	2.69
50.	57	5.14	2.72

TABLE 3.90

EMISSIONS FOR 10% TO 50% WORST EMITTING VEHICLES
FEDERAL TEST PROCEDURE

	HYDROCARBONS						CARBON MONOXIDE						NOX					
	72-74			75-76			72-74			75-76			72-74			75-76		
	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD
10%	8	13.19	8.22	11	4.80	2.37	8	170.09	31.52	11	129.78	60.74	8	1.41	0.54	11	1.31	0.44
20%	16	8.98	7.12	22	4.14	1.84	16	144.80	34.48	22	104.30	49.86	16	1.62	0.66	22	1.48	0.42
30%	25	7.77	5.89	33	3.63	1.68	25	127.83	35.81	33	90.91	44.76	25	1.79	1.05	33	1.42	0.44
40%	33	7.20	5.29	44	3.35	1.59	33	115.67	38.43	44	81.67	41.90	33	1.75	1.03	44	1.39	0.43
50%	41	6.71	4.85	56	3.13	1.57	41	100.29	37.58	56	73.93	40.02	41	1.76	0.94	56	1.43	0.58

EMISSIONS FOR 10% TO 50% WORST EMITTING VEHICLES
COLD TRANSIENT (GM)

	HYDROCARBONS						CARBON MONOXIDE						NOX					
	72-74			75-76			72-74			75-76			72-74			75-76		
	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD
10%	8	77.40	64.94	11	26.32	11.60	8	743.71	331.62	11	560.05	222.57	8	5.72	2.67	11	4.95	1.67
20%	16	51.19	52.14	22	22.14	10.25	16	645.82	250.05	22	461.32	191.94	16	6.89	2.84	22	5.72	1.83
30%	25	42.23	43.20	33	19.40	9.25	25	563.43	230.43	33	413.77	169.93	25	7.49	4.91	33	6.03	1.88
40%	33	37.26	38.51	44	17.62	8.65	33	521.34	213.45	44	381.48	157.21	33	7.59	4.65	44	6.30	2.03
50%	41	34.21	35.08	56	16.69	8.07	41	486.04	205.07	56	349.54	153.54	41	8.19	4.86	56	6.98	3.31

EMISSIONS FOR 10% TO 50% WORST EMITTING VEHICLES
COLD STABILIZED (GM)

	HYDROCARBONS						CARBON MONOXIDE						NOX					
	72-74			75-76			72-74			75-76			72-74			75-76		
	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD
10%	8	45.92	34.29	11	16.36	8.21	8	687.09	139.34	11	503.56	225.68	8	4.06	1.46	11	3.56	1.53
20%	16	32.52	27.30	22	14.98	6.02	16	574.83	153.87	22	411.34	182.88	16	4.50	1.88	22	4.37	1.59
30%	25	27.88	22.57	33	13.37	5.59	25	500.08	158.72	33	351.18	171.88	25	5.22	2.92	33	4.14	1.48
40%	33	25.62	20.36	44	12.03	5.41	33	451.03	164.71	44	309.71	165.20	33	5.31	2.81	44	4.23	1.59
50%	41	23.72	18.70	56	10.79	5.42	41	418.77	161.58	56	276.71	159.41	41	5.58	2.84	56	4.15	1.58

TABLE 3.91

CLAYTON CAUSES OF HIGH HC EMISSIONS

Type 1 Causes

Abnormally high HC in one of the following Modes:

Idle

Idle and Low Cruise

Usual Causes

1. Vacuum leaks into the intake manifold causing a lean mixture and subsequent misfire in some cylinders.

2. Idle circuits on 2 and 4 barrel carburetors highly imbalanced or adjusted too lean.

3. Intermittent ignition misfire is possible but not probable.

4. Grossly advanced ignition timing.

5. Modest compression leak through one or more exhaust valves.

6. Excessively high CO at idle can cause moderately high HC at idle.

Type 2 Causes

Abnormally high HC in one of the following Modes:

Low Cruise

High Cruise

High and Low Cruise

High Cruise and Idle

High, Low Cruises, and Idle

Usual Causes

1. Ignition misfire under higher compression pressures of power operation, due to failure of an ignition system component.

TABLE 3.92

CLAYTON CAUSES OF HIGH CO EMISSIONS

Type 1' Causes

Abnormally high CO in one of the following Modes:

Idle
Idle and Low Cruise

Usual Causes
Gross error in carburetor idle air fuel mixture adjustment.

Type 2' Causes

Abnormally high CO in one of the following Modes:

Low Cruise
High Cruise
High Cruise and Low Cruise

Usual Causes
Main system carburetor malfunction. This problem cannot be corrected by an idle adjustment only.

Type 3' Causes

Abnormally high CO in one of the following Modes:

High Cruise and Idle
High, Low Cruises, and Idle

Usual Causes
1. Gross error in carburetor idle air fuel mixture adjustment.

2. Main system carburetor malfunction. This problem cannot be corrected by an idle adjustment only.

TABLE 3.93

PERCENT OF VEHICLES FAILING FEDERAL HC STANDARDS WITH HIGH HC EMISSIONS ON FEDERAL THREE MODE TEST FOR 1972-1974 MODEL YEAR VEHICLES

		Type 1 Cause		Type 2 Cause				
Manufacturer	Number of FTP HC Failures	Idle	Low Cruise & Idle	Low Cruise	High Cruise	High & Low Cruise	High Cruise & Idle	High & Low Cruise & Idle
GM	33	3	3	0	21	3	3	9
Ford	19	5	0	0	21	11	11	11
Chrysler	10	0	10	0	0	20	0	50
AMC	3	33	0	0	0	67	0	33
U.S. Manufacturers	65	5	3	0	17	11	5	17
Foreign Manufacturers	13	31	0	15	15	8	0	15
Total	78	9	3	3	17	10	4	17

PERCENT OF VEHICLES BY CAUSE

Manufacturer	Type 1 Cause	Type 2 Cause
GM	6	36
Ford	5	54
Chrysler	10	70
AMC	33	100
U.S. Manfacturers	8	50
Foreign Manufacturers	31	53
Total	12	51

TABLE 3.94

PERCENT OF VEHICLES FAILING FEDERAL CO STANDARDS WITH HIGH CO EMISSIONS ON FEDERAL THREE MODE TEST FOR 1972-1974 MODEL YEAR VEHICLES

		Type 1' Cause		Type 2' Cause			Type 3' Cause	
Manufacturer	Number of FTP CO Failures	Idle	Low Cruise & Idle	Low Cruise	High Cruise	High & Low Cruise	High Cruise & Idle	High & Low Cruise & Idle
GM	36	8	19	6	8	6	6	44
Ford	18	33	11	0	6	17	0	33
Chrysler	10	0	30	10	0	20	10	30
AMC	3	0	33	0	0	0	0	67
U.S. Manufacturers	67	13	18	4	6	10	4	40
Foreign Manufacturers	14	7	21	0	0	14	21	36
Total	81	12	19	4	5	11	7	40

PERCENT OF VEHICLES BY CAUSE

Manufacturer	Type 1' Cause	Type 2' Cause	Type 3' Cause
GM	77	20	50
Ford	44	23	33
Chrysler	30	30	40
AMC	33	0	67
U.S. Manufacturers	31	20	44
Foreign Manufacturers	28	14	57
Total	31	20	47

TABLE 3.95

PERCENT OF VEHICLES FAILING FEDERAL HC STANDARDS WITH HIGH HC EMISSIONS ON FEDERAL THREE MODE TEST FOR 1975-1976 MODEL YEAR VEHICLES

		Type 1 Cause		Type 2 Cause				
Manufacturer	Number of FTP HC Failures	Idle	Low Cruise & Idle	Low Cruise	High Cruise	High & Low Cruise	High Cruise & Idle	High & low Cruise & Idle
GM	25	16	28	20	0	4	0	20
Ford	11	0	18	18	0	9	0	18
Chrysler	14	14	43	7	0	0	0	21
AMC	4	0	50	25	0	0	0	0
U.S. Manufacturers	54	11	31	17	0	4	0	19
Foreign Manufacturers	21	21	14	38	0	24	0	19
Total	75	8	27	23	0	9	0	19

PERCENT OF VEHICLES BY CAUSE

Manufacturer	Type 1 Cause	Type 2 Cause
GM	44	44
Ford	18	45
Chrysler	57	28
AMC	50	25
U.S. Manufacturers	42	40
Foreign Manufacturers	35	81
Total	35	51

TABLE 3.96

PERCENT OF VEHICLES FAILING FEDERAL CO STANDARDS WITH HIGH CO EMISSIONS ON FEDERAL THREE MODE TEST FOR 1975-1976 MODEL YEAR VEHICLES

		Type 1' Cause		Type 2' Cause			Type 3' Cause	
Manufacturer	Number of FTP CO Failures	Idle	Low Cruise & Idle	Low Cruise	High Cruise	High & Low Cruise	High Cruise & Idle	High & Low Cruise & Idle
GM	37	3	24	0	5	16	3	41
Ford	23	0	30	9	4	13	3	30
Chrysler	13	0	38	0	8	8	0	38
AMC	5	20	20	0	0	0	0	60
U.S. Manufacturers	78	3	28	3	5	13	3	38
Foreign Manufacturers	22	9	23	0	5	5	0	55
Total	100	4	27	2	5	11	2	42

PERCENT OF VEHICLES BY CAUSE

Manufacturer	Type 1' Cause	Type 2' Cause	Type 3' Cause
GM	77	21	44
Ford	30	26	34
Chrysler	38	16	38
AMC	40	0	60
U.S. Manufacturers	31	21	41
Foreign Manufacturers	32	10	55
Total	31	18	44

TABLE 3.97

PERCENTAGE OF VEHICLES WITH MALADJUSTED OR DISABLED EMISSION SYSTEMS OR COMPONENTS

Emission Related System/Component	All Phase I Vehicles		Passing Phase I Vehicles		Failing Phase 1/ Failing Phase 2 Vehicles	
	N	%	N	%	N	%
Exhaust	2	1.0	2	1.6	1	0.4
Air	4	2.1	3	2.4	1	0.4
EGR	3	1.6	2	1.6	9	3.5
Air Cleaner	11	5.7	6	4.8	16	6.2
Limiter Caps	96	49.7	53	42.7	176	68.2
Timing	94	48.7	56	45.2	162	62.8
Advance Mech.	1	0.5	1	0.8	4	1.6
Fuel	1	0.5	0	0.0	4	1.6
Per Phase	137	71.0	82	66.1	221	85.7

Per Phase values represent the number of vehicles with at least one maladjusted/disabled system.

TABLE 3.98

PERCENTAGE OF VEHICLES WITH MALADJUSTED/DISABLED EMISSION SYSTEMS/COMPONENTS
BY MANUFACTURER, 1975-1976 MODEL YEAR VEHICLES

Manufacturer	System/Component	All Phase 1 Vehicles		Passing Phase 1 Vehicles		Failing Phase 1/ Failing Phase 2 Vehicles	
		N	%	N	%	N	%
General Motors	Limiter Caps	16	40.0	8	29.6	42	75.0
	Timing	12	30.0	6	22.2	37	66.1
	Per Manufacturer	25	62.5	15	55.6	50	89.3
Ford	Limiter Caps	13	52.0	8	40.0	11	68.8
	Timing	11	44.0	8	40.0	11	68.8
	Per Manufacturer	17	68.0	12	60.0	15	93.8
Chrysler	Limiter Caps	10	66.7	2	40.0	21	72.4
	Timing	8	53.3	1	20.0	20	69.0
	Per Manufacrurer	12	80.0	3	60.0	25	86.2
American Motors	Limiter Caps	3	50.0	2	100.0	2	22.2
	Timing	4	66.7	1	50.0	7	77.8
	Per Manufacturer	5	83.3	2	100.0	7	77.8
Foreign	Limiter Caps	5	20.0	4	22.2	3	21.4
	Timing	12	48.0	11	61.1	5	35.7
	Per Manufacturer	13	52.0	11	61.1	7	50.0
Total	Limiter Caps	47	42.3	24	33.3	79	63.7
	Timing	47	42.3	27	37.5	80	64.5
	Per Manufacturer	72	64.9	43	59.7	104	83.9

Per Manufacturer category represents the number of vehicles with at least one maladjusted/disabled emission-related system/component of any type.

TABLE 3.99

PERCENTAGE OF VEHICLES WITH MALADJUSTED/DISABLED EMISSION SYSTEMS/COMPONENTS BY MILEAGE, 1972-1974 MODEL YEAR VEHICLES

Mileage	System/Component	All Phase 1 Vehicles N	All Phase 1 Vehicles %	Passing Phase 1 Vehicles N	Passing Phase 1 Vehicles %	Failing Phase 1/ Failing Phase 2 Vehicles N	Failing Phase 1/ Failing Phase 2 Vehicles %
less than 20000	Limiter Caps	11	47.8	6	37.5	14	66.7
	Timing	10	43.5	8	50.0	8	38.1
	Per Mileage Group	17	73.9	11	68.8	16	76.2
20000 to 30000	Limiter Caps	9	69.2	7	70.0	23	69.7
	Timing	8	61.5	7	70.0	19	57.6
	Per Mileage Group	10	76.9	8	80.0	28	84.8
30000 to 40000	Limiter Caps	12	60.0	7	58.3	21	70.0
	Timing	14	70.0	6	50.0	22	73.3
	Per Mileage Group	17	85.0	9	75.0	29	96.3
40000 to 50000	Limiter Caps	8	57.1	5	55.6	15	71.4
	Timing	9	64.3	5	55.6	15	71.4
	Per Mileage Group	11	78.6	7	77.8	17	81.0
greater than 50000	Limiter Caps	9	75.0	4	80.0	24	82.8
	Timing	6	50.0	3	60.0	18	62.1
	Per Mileage Group	10	83.3	4	80.0	27	93.1
Total	Limiter Caps	49	59.8	29	55.8	97	72.4
	Timing	47	57.3	29	55.8	82	61.2
	Per Mileage Group	65	79.3	39	75.0	117	87.3

Per Mileage Group values represent the number of vehicles with at least one maladjusted/disabled, emission-related system/component of any type.

TABLE 3.100

PERCENTAGE OF VEHICLES WITH MALADJUSTED/DISABLED EMISSION SYSTEMS/COMPONENTS BY MILEAGE, 1975-1976 MODEL YEAR VEHICLES

Mileage	System/Component	All Phase 1 Vehicles N	All Phase 1 Vehicles %	Passing Phase 1 Vehicles N	Passing Phase 1 Vehicles %	Failing Phase 1/ Failing Phase 2 Vehicles N	Failing Phase 1/ Failing Phase 2 Vehicles %
less than 5000	Limiter Caps	4	33.3	3	30.0	2	50.0
	Timing	3	25.0	3	30.0	0	0.0
	Per Mileage Group	6	50.0	5	50.0	2	50.0
50000 to 10000	Limiter Caps	15	45.5	7	33.3	17	63.0
	Timing	19	57.6	10	47.6	17	63.0
	Per Mileage Group	26	78.8	15	71.4	23	85.2
10000 to 15000	Limiter Caps	10	40.0	5	33.3	16	57.1
	Timing	15	60.0	8	53.3	20	71.4
	Per Mileage Group	17	68.0	10	66.7	23	82.1
15000 to 20000	Limiter Caps	11	47.8	6	42.9	18	66.7
	Timing	3	13.0	2	14.3	14	51.9
	Per Mileage Group	12	52.2	7	50.0	21	77.8
greater than 20000	Limiter Caps	7	38.9	3	25.0	26	68.4
	Timing	7	38.9	4	33.3	29	76.3
	Per Mileage Group	11	61.1	6	50.0	35	92.1
Total	Limiter Caps	47	42.3	24	33.3	79	63.7
	Timing	47	42.3	27	39.5	80	64.5
	Per Mileage Group	72	64.9	43	59.7	104	83.9

Per Mileage Group values represent the number of vehicles with at least one maladjusted/disabled, emission-related system/component of any type.

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TABLE 3.101

1975 FTP ALL PHASE I VEHICLES WITH MALADJUSTMENTS/DISABLEMENTS BY MANUFACTURER
1975-1976 MODEL YEAR VEHICLES

MANUFACTURER	SYSTEM/COMPONENT	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	LIMITER CAPS	16	2.42	1.67	58.78	44.14	1.45	0.43	13.73	3.52
	TIMING	12	2.54	1.63	59.79	40.44	1.40	0.67	15.39	3.94
	PER MANUFACTURER	25	2.19	1.40	57.26	37.65	1.54	0.56	14.24	3.32
FORD	LIMITER CAPS	13	2.61	2.70	64.85	74.53	1.61	0.57	11.76	2.08
	TIMING	11	1.91	1.06	43.89	27.70	1.85	0.78	13.18	2.09
	PER MANUFACTURER	17	2.48	2.47	61.34	66.77	1.64	0.51	12.34	2.54
CHRYSLER	LIMITER CAPS	10	3.40	1.36	82.00	38.59	1.67	0.39	12.47	1.99
	TIMING	8	3.52	1.08	78.74	29.56	1.75	0.39	12.61	1.86
	PER MANUFACTURER	12	3.36	1.23	77.95	36.23	1.69	0.38	12.73	2.19
AMERICAN MOTORS	LIMITER CAPS	3	1.34	0.79	17.84	13.03	3.93	2.24	16.07	2.68
	TIMING	4	1.94	0.61	27.86	10.84	2.78	0.81	17.59	2.74
	PER MANUFACTURER	5	1.70	0.75	24.10	12.60	3.50	1.75	17.00	2.55
FOREIGN	LIMITER CAPS	5	2.26	0.41	42.10	18.38	1.45	0.87	20.38	3.99
	TIMING	12	2.16	0.49	43.59	14.02	1.76	0.97	20.13	3.19
	PER MANUFACTURER	13	2.17	0.47	42.14	15.12	1.82	0.95	20.14	3.05
TOTAL	LIMITER CAPS	47	2.59	1.90	61.03	51.72	1.70	0.90	13.41	3.30
	TIMING	47	2.41	1.21	52.44	31.24	1.80	0.72	15.30	3.84
	PER ALL MANUFACTURERS	72	2.42	1.60	54.91	43.97	1.77	0.86	14.35	3.69

PER MANUFACTURER VALUES REPRESENT THE VEHICLES WITH AT LEAST ONE EMISSION-RELATED MALADJUSTED/DISABLED SYSTEM/COMPONENT OF ANY TYPE.

TABLE 3.102

1975 FTP ALL PHASE I VEHICLES WITHOUT MALADJUSTMENTS/DISABLEMENTS BY MANUFACTURER - 1975-1976 MODEL YEAR VEHICLES

MANUFACTURER	SYSTEM/COMPONENT	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	LIMITER CAPS	24	1.96	0.76	45.84	20.99	1.68	1.02	13.97	1.75
	TIMING	28	1.97	0.96	47.25	28.32	1.64	0.91	13.31	1.92
	PER MANUFACTURER	15	2.05	0.83	48.90	22.12	1.67	1.19	13.31	1.00
FORD	LIMITER CAPS	12	1.56	0.77	37.89	23.96	1.53	0.45	12.69	2.86
	TIMING	14	2.27	2.69	58.20	72.63	1.35	0.54	11.51	2.39
	PER MANUFACTURER	8	1.31	0.45	31.87	14.36	1.43	0.49	11.89	2.34
CHRYSLER	LIMITER CAPS	5	3.17	0.79	59.88	9.37	1.95	0.41	14.01	1.95
	TIMING	7	3.09	1.32	70.04	38.73	1.78	0.45	13.36	2.41
	PER MANUFACTURER	3	3.18	1.12	61.60	12.65	2.04	0.46	13.88	0.52
AMERICAN MOTORS	LIMITER CAPS	3	2.49	0.40	45.96	21.60	2.56	0.84	16.93	2.73
	TIMING	2	1.84	1.56	39.98	43.71	4.17	3.11	14.67	0.48
	PER MANUFACTURER	1	2.95	0.00	70.88	0.00	1.98	0.00	14.34	0.00
FOREIGN	LIMITER CAPS	20	2.27	1.04	35.85	15.17	1.72	0.82	18.96	6.95
	TIMING	13	2.38	1.23	31.12	14.41	1.58	0.69	18.47	8.07
	PER MANUFACTURER	12	2.38	1.29	31.64	14.91	1.50	0.66	18.34	8.29
TOTAL	LIMITER CAPS	64	2.10	0.93	42.33	19.94	1.73	0.84	15.05	3.98
	TIMING	64	2.24	1.58	48.64	42.22	1.66	0.95	13.67	3.55
	PER ALL MANUFACTURERS	39	2.11	1.05	41.64	20.43	1.61	0.85	14.23	3.88

PER MANUFACTURER VALUES REPRESENT THE VEHICLES WITH NO EMISSION-RELATED MALADJUSTED/DISABLED SYSTEM/COMPONENT OF ANY TYPE.

TABLE 3.103

1975 FTP ALL PHASE I VEHICLES WITH MALADJUSTMENTS/DISABLEMENTS BY MILEAGE 1972-1974 MODEL YEAR VEHICLES

MILEAGE	SYSTEM/COMPONENT	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
LESS THAN 20000	LIMITER CAPS	11	4.20	1.01	81.05	33.53	1.80	0.94	12.56	3.42
	TIMING	10	4.54	1.14	76.64	22.22	1.83	1.13	13.41	2.96
	PER MILEAGE GROUP	17	4.51	1.10	78.19	29.74	1.77	0.95	13.52	3.87
20000 TO 30000	LIMITER CAPS	9	5.82	3.38	109.02	46.55	2.11	1.41	12.03	2.22
	TIMING	8	5.88	3.49	105.04	43.20	2.13	1.50	12.17	1.98
	PER MILEAGE GROUP	10	5.79	3.19	106.50	44.60	2.11	1.33	11.97	2.08
30000 TO 40000	LIMITER CAPS	12	6.17	3.17	89.51	40.80	2.71	1.05	14.07	2.84
	TIMING	14	6.17	2.83	85.22	41.21	2.52	1.00	15.33	3.83
	PER MILEAGE GROUP	17	5.95	2.68	84.74	38.14	2.49	0.97	14.81	3.53
40000 TO 50000	LIMITER CAPS	8	8.38	9.83	94.11	14.56	2.18	1.10	12.89	2.33
	TIMING	9	7.59	9.43	78.37	19.38	3.24	1.65	13.90	2.99
	PER MILEAGE GROUP	11	7.15	8.49	83.51	22.16	2.90	1.67	13.37	2.78
GREATER THAN 50000	LIMITER CAPS	9	6.67	2.50	132.35	52.85	1.73	0.65	11.86	2.53
	TIMING	6	6.30	2.35	122.90	60.02	1.51	0.23	12.29	3.02
	PER MILEAGE GROUP	10	6.57	2.37	124.98	55.01	1.74	0.61	12.23	2.82
TOTAL	LIMITER CAPS	49	6.12	4.62	99.81	42.43	2.13	1.07	12.71	2.76
	TIMING	47	6.06	4.63	90.27	39.62	2.32	1.29	13.61	3.12
	PER ALL MILEAGE GROUPS	65	5.85	4.05	92.36	40.58	2.20	1.18	13.32	3.21

PER MILEAGE GROUP VALUES REPRESENT THE VEHICLES WITH AT LEAST ONE EMISSION-RELATED MALADJUSTED/DISABLED SYSTEM/COMPONENT OF ANY TYPE.

TABLE 3.104

1975 FTP ALL PHASE I VEHICLES WITHOUT MALADJUSTMENTS/DISABLEMENTS BY MILEAGE
1972-1974 MODEL YEAR VEHICLES

MILEAGE	SYSTEM/COMPONENT	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
LESS THAN 20000	LIMITER CAPS	12	5.17	1.26	77.24	25.31	2.11	0.99	13.50	3.61
	TIMING	13	4.84	1.32	80.92	33.94	2.06	0.83	12.77	3.84
	PER MILEAGE GROUP	6	5.26	1.50	81.54	28.89	2.51	0.81	11.84	2.45
20000 TO 30000	LIMITER CAPS	4	5.91	1.72	83.95	5.39	1.67	0.67	12.33	3.07
	TIMING	5	5.79	1.92	95.33	38.10	1.73	0.64	12.04	3.13
	PER MILEAGE GROUP	3	6.04	2.08	83.98	6.60	1.54	0.75	12.63	3.88
30000 TO 40000	LIMITER CAPS	8	8.40	9.42	91.37	64.77	1.72	0.63	15.56	6.26
	TIMING	6	9.15	11.08	102.00	69.90	1.84	0.96	13.23	4.48
	PER MILEAGE GROUP	3	13.35	15.83	121.47	102.43	1.32	0.73	13.72	7.22
40000 TO 50000	LIMITER CAPS	6	4.45	1.42	67.41	27.55	3.51	1.73	14.14	4.45
	TIMING	5	5.09	1.43	90.39	32.61	1.87	0.64	12.59	3.46
	PER MILEAGE GROUP	3	5.03	2.01	79.58	37.26	2.22	0.52	13.52	5.16
GREATER THAN 50000	LIMITER CAPS	3	5.61	1.83	77.93	39.35	1.45	0.36	13.41	6.11
	TIMING	6	6.50	2.50	114.60	52.71	1.81	0.81	12.13	3.67
	PER MILEAGE GROUP	2	5.56	2.59	87.58	50.39	1.25	0.06	12.10	6.43
TOTAL	LIMITER CAPS	33	5.95	4.79	79.75	37.72	2.16	1.19	13.89	4.30
	TIMING	35	6.03	4.76	93.72	44.53	1.91	0.77	12.60	3.55
	PER ALL MILEAGE GROUPS	17	6.82	6.58	89.38	46.37	1.93	0.82	12.59	3.88

PER MILEAGE GROUP VALUES REPRESENT THE VEHICLES WITH NO EMISSION-RELATED MALADJUSTED/DISABLED SYSTEM/COMPONENT OF ANY TYPE.

TABLE 3.105

1975 FTP ALL PHASE I VEHICLES WITH MALADJUSTMENTS/DISABLEMENTS BY MILEAGE
1975-1976 MODEL YEAR VEHICLES

MILEAGE	SYSTEM/COMPONENT	N	HYDROCARBONS		CARBON MONOXIDE		NOX		FUEL ECONOMY	
			MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
LESS THAN 5000	LIMITER CAPS	4	1.85	1.07	46.76	38.56	0.92	0.21	14.66	1.67
	TIMING	3	1.35	0.57	29.10	14.03	2.01	1.19	17.40	0.35
	PER MILEAGE GROUP	6	1.58	0.93	38.84	32.81	1.51	0.93	15.53	2.03
5000 TO 10000	LIMITER CAPS	15	2.52	1.65	55.39	42.09	1.64	0.79	15.56	4.12
	TIMING	19	2.50	1.37	57.14	34.65	1.76	0.98	16.79	4.27
	PER MILEAGE GROUP	26	2.23	1.33	48.48	34.26	1.77	0.90	16.35	3.91
10000 TO 15000	LIMITER CAPS	10	1.82	1.25	38.42	31.47	2.25	1.47	14.10	2.73
	TIMING	15	2.33	1.05	50.86	28.43	1.79	0.39	14.21	3.33
	PER MILEAGE GROUP	17	2.17	1.09	46.62	29.24	2.05	1.17	14.46	3.35
15000 TO 20000	LIMITER CAPS	11	3.49	2.84	84.27	76.79	1.58	0.49	11.69	2.95
	TIMING	3	3.25	1.84	46.31	35.63	2.03	0.25	14.27	5.56
	PER MILEAGE GROUP	12	3.47	2.71	81.85	73.69	1.58	0.47	12.03	3.21
GREATER THAN 20000	LIMITER CAPS	7	2.87	1.36	77.05	44.32	1.66	0.39	11.35	1.06
	TIMING	7	2.42	0.92	55.71	33.56	1.73	0.48	13.93	2.95
	PER MILEAGE GROUP	11	2.54	1.17	62.32	40.05	1.72	0.40	12.70	2.53
TOTAL	LIMITER CAPS	47	2.59	1.90	61.03	51.72	1.70	0.90	13.41	3.30
	TIMING	47	2.41	1.21	52.44	31.24	1.80	0.72	15.30	3.84
	PER ALL MILEAGE GROUPS	72	2.42	1.60	54.91	43.97	1.77	0.86	14.35	3.69

PER MILEAGE GROUP VALUES REPRESENT THE VEHICLES WITH AT LEAST ONE EMISSION-RELATED MALADJUSTED/DISABLED SYSTEM/COMPONENT OF ANY TYPE.

TABLE 3.106

1975 FTP ALL PHASE I VEHICLES WITHOUT MALADJUSTMENTS/DISABLEMENTS BY MILEAGE
1975-1976 MODEL YEAR VEHICLES

MILEAGE	SYSTEM/COMPONENT	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
LESS THAN 5000	LIMITER CAPS	8	1.95	1.39	28.45	15.75	1.61	0.80	15.79	6.70
	TIMING	9	2.10	1.37	36.37	28.67	1.18	0.43	14.82	5.53
	PER MILEAGE GROUP	6	2.25	1.50	30.27	17.24	1.26	0.52	15.27	7.32
5000 TO 10000	LIMITER CAPS	18	1.93	0.70	40.84	20.95	1.67	0.92	16.39	3.89
	TIMING	14	1.78	0.94	34.32	25.09	1.53	0.65	15.05	3.55
	PER MILEAGE GROUP	7	2.07	0.94	43.67	27.46	1.25	0.48	14.84	4.17
10000 TO 15000	LIMITER CAPS	15	2.20	0.95	43.91	24.85	1.78	0.54	14.99	4.02
	TIMING	10	1.64	1.01	27.99	19.12	2.25	1.55	15.29	3.76
	PER MILEAGE GROUP	8	1.81	1.06	31.29	19.96	1.79	0.61	14.97	3.94
15000 TO 20000	LIMITER CAPS	12	2.62	1.01	57.70	9.43	1.43	0.36	13.76	2.56
	TIMING	20	3.01	2.17	74.02	55.94	1.42	0.39	12.48	2.74
	PER MILEAGE GROUP	11	2.56	1.04	57.92	9.86	1.42	0.37	13.49	2.39
GREATER THAN 20000	LIMITER CAPS	11	1.78	0.58	35.93	11.57	2.14	1.28	14.20	3.56
	TIMING	11	2.06	1.18	49.51	36.66	2.10	1.28	12.38	2.71
	PER MILEAGE GROUP	7	1.68	0.65	35.59	14.50	2.33	1.59	13.33	3.51
TOTAL	LIMITER CAPS	64	2.10	0.93	42.33	19.94	1.73	0.84	15.05	3.98
	TIMING	64	2.24	1.58	48.64	42.22	1.66	0.95	13.67	3.55
	PER ALL MILEAGE GROUPS	39	2.11	1.05	41.64	20.43	1.61	0.85	14.23	3.88

PER MILEAGE GROUP VALUES REPRESENT THE VEHICLES WITH NO EMISSION-RELATED MALADJUSTED/DISABLED SYSTEM/COMPONENT OF ANY TYPE.

TABLE 3.107

STUDENT t STATISTICS FOR TESTING MEAN EMISSIONS WITH AND WITHOUT MALADJUSTMENTS AND DISABLEMENTS BY MANUFACTURER, 1975-1976 VEHICLES, PHASE I VEHICLES

Manufacturer	System/Component	HC	CO	NOX	F.E.
General Motors	Limiter Caps	1.03	1.09	-0.98	-0.25
	Timing	1.13	0.98	-0.62	1.74*
	Per Manufacturer	0.40	0.36	-0.40	1.31
Ford	Limiter Caps	1.31	1.24	0.39	-0.92
	Timing	-0.46	-0.68	2.99*	1.86*
	Per Manufacturer	1.89*	1.74*	0.99	0.44
Chrysler	Limiter Caps	0.41	1.72	-1.27	-1.43
	Timing	0.68	0.48	-0.14	-0.67
	Per Manufacturer	0.24	1.28	-1.22	-1.64
American Motors	Limiter Caps	-2.25	-1.93	0.99	-0.39
	Timing	0.09	0.39	-0.62	2.07
	Per Manufacturer	**	**	**	**
Foreign	Limiter Caps	-0.30	0.70	-0.63	0.60
	Timing	-0.60	2.13*	0.53	0.69
	Per Manufacturer	-0.53	1.75*	0.98	0.71
Total	Limiter Caps	1.63	2.35*	-0.18	-2.37*
	Timing	0.64	0.54	0.88	2.28*
	Per All Mfgrs.	1.23	2.17*	0.94	0.16

* Significant at 95 percent level of confidence.
** Insufficient data for comparison.
Per Manufacturer values represent the t statistics for comparing vehicles with at least one emission related maladjusted/disabled system/component of any type to vehicles with no emission related maladjusted/disabled system/component of any type.

TABLE 3.108

STUDENT t STATISTICS FOR TESTING MEAN EMISSIONS WITH AND WITHOUT MALADJUSTMENTS AND DISABLEMENTS BY MILEAGE AND MODEL YEAR, PHASE I VEHICLES

	1972-1974					1975-1976				
System/Component	Mileage Increment	HC	CO	NOX	F.E.	Mileage Increment	HC	CO	NOX	F.E.
Limiter Cap	less than 20000	-2.04*	0.31	-0.77	-0.64	less than 5000	-0.14	0.91	-2.29	-0.45
Timing		-0.58	-0.36	-0.54	0.45		-1.33	-0.58	1.18	1.39
Per Mileage Group		-1.12	-0.24	-1.84*	1.22		-0.93	0.57	0.57	0.08
Limiter Cap	20000 to 30000	-0.06	1.59	0.76	-0.18	5000 10000	1.29	1.22	-0.10	-0.59
Timing		0.06	0.42	0.66	0.08		1.79*	2.19*	0.81	1.28
Per Mileage Group		-0.16	1.54	0.94	-0.28		0.36	0.39	2.05	0.86
Limiter Cap	30000 to 40000	-0.65	-0.07	2.63*	-0.63	10000 to 15000	-0.82	-0.46	0.97	-0.66
Timing		-0.65	-0.55	1.43	1.00		1.65	2.40*	-0.92	-0.74
Per Mileage Group		-0.81	-0.61	1.73	0.26		0.78	1.53	0.73	-0.32
Limiter Cap	40000 to 50000	1.12	2.16*	-1.65	-0.63	15000 to 20000	0.96	1.14	0.83	-1.79*
Timing		0.78	-0.75	2.21*	0.71		0.21	-1.15	3.62*	-0.55
Per Mileage Group		0.75	0.17	1.16	-0.05		1.08	1.11	0.91	-1.24
Limiter Cap	more than 50000	0.79	1.89	0.93	-0.43	more than 20000	2.01*	2.40*	-1.16	-2.49*
Timing		-0.14	0.25	-0.87	0.08		0.72	0.37	-0.87	1.12
Per Mileage Group		0.51	0.94	2.48	0.03		2.00*	2.02*	-1.00	-0.41
Limiter Cap	Total	0.16	2.24	-0.12	-1.39	Total	1.63	2.35*	-0.18	-2.37*
Timing		0.03	-0.36	1.79*	1.34		0.64	0.54	0.88	2.28
Per Mileage Group		-0.58	0.24	1.09	-0.71		1.23	2.17*	0.94	0.16

* Significant at 95 percent level of confidence.

Per Mileage Group values represent the t statistics for comparing vehicles with at least one emission related maladjusted/disabled system/component of any type to vehicles with no emission related maladjusted/disabled system/component of any type.

TABLE 3.109

PERCENTAGES OF VEHICLES BY OWNER RESPONSE TO QUESTIONNAIRE THAT HAVE MALADJUSTED OR DISABLED SYSTEMS/COMPONENT, ALL FAILING PHASE II

Question	Responses	Limiter Caps	Timing	At least One System*	Number of Responses
Hard Starting?	yes	76	56	84	25
	no	70	67	88	164
Stalls?	yes	77	77	91	22
	no	69	68	87	167
Rough idle?	yes	85	67	91	33
	no	67	65	87	156
Poor Acceleration?	yes	81	67	95	21
	no	69	65	87	168
No Major Problems	yes	71	66	90	106
	no	70	74	86	83
Last Tuned?	0-6 months	73	60	89	89
	6-12 months	29	66	92	38
	over 12 mo.	63	71	79	38
Who Tuned?	Dealer	71	63	84	93
	Indep. Garage	77	60	92	52
	Self	68	74	89	19
Maintained to Manufacturer Recommendations?	yes	71	67	88	155
	no	78	61	83	18
Unleaded Fuel Required?	yes	68	71	89	79
	no	72	62	87	110

* Percentage of vehicles with at least one emission related maladjustment/disabled system/component of any type.

TABLE 3.110

PERCENTAGES OF VEHICLES BY OWNER RESPONSE TO QUESTIONNAIRE THAT HAVE MALADJUSTED OR DISABLED SYSTEMS/COMPONENT, 1972-1974 MODEL YEAR, FAILING PHASE II VEHICLES

Question	Response	Limiter Caps	Timing	At Least One System*	At Least Response
Hard Starting?	yes	69	38	69	13
	no	75	65	90	91
Stalls?	yes	83	83	83	6
	no	73	60	88	98
Rough Idle?	yes	88	65	88	17
	no	71	61	87	87
Poor Acceleration?	yes	78	56	100	9
	no	74	62	86	95
No Major Problems	yes	76	65	90	62
	no	71	57	83	42
Last Tuned?	0-6 months	75	54	86	59
	6-12 months	90	70	95	20
	over 12 mo.	50	57	71	14
Who Tuned?	Dealer	73	54	78	37
	Indep. Garage	85	58	93	40
	Self	65	71	88	17
Maintained to Manufacturer Recommendations?	yes	76	63	88	82
	no	75	58	83	12
Unleaded Fuel Required?	yes	0	0	0	1
	no	75	62	88	103

* Percentage of vehicles with at least one emission related maladjusted/disabled system/component of any type.

TABLE 3.111

PERCENTAGES OF VEHICLES BY OWNER RESPONSE TO QUESTIONNAIRE THAT HAVE MALADJUSTED OR DISABLED SYSTEMS/COMPONENT, 1975-1976 MODEL YEAR, FAILING PHASE II VEHICLES

Question	Response	Limiter Caps	Timing	At least One System*	Number of Responses
Hard Starting?	yes	83	75	100	12
	no	63	70	86	73
Stalls?	yes	75	75	94	16
	no	64	70	87	69
Rough Idle?	yes	81	69	94	16
	no	62	71	87	69
Poor Acceleration?	yes	83	75	92	12
	no	63	70	88	73
No Major Problems	yes	64	68	89	44
	no	68	73	88	41
Last Tuned?	0-6 months	70	70	93	30
	6-12 months	67	61	89	18
	over 12 mo.	71	79	83	24
Who Tuned?	Dealer	70	70	88	56
	Indep. Garage	50	67	92	12
	Self	100	100	100	2
Maintained to Manufacturer Recommendations?	yes	66	71	89	73
	no	83	67	83	6
Unleaded Fuel Required?	yes	69	72	90	78
	no	29	57	71	7

* Percentage of vehicles with at least one emission related maladjusted/disabled system/component of any type.

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TABLE 3.112

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES * BY MANUFACTURER
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR

MANUFACTURER	TOTAL	TIMING		IDLE RPM		IDLE CO		FAILING ALL	
	N	N	%	N	%	N	%	N	%
GENERAL MOTORS	40	14	35.0	5	12.5	16	40.0	2	5.0
FORD	25	14	56.0	4	16.0	13	52.0	1	4.0
CHRYSLER	15	11	73.3	2	13.3	13	86.7	1	6.7
AMERICAN MOTORS	6	4	66.7	2	33.3	4	66.7	1	16.7
FOREIGN	25	11	44.0	7	28.0	19	76.0	4	16.0
TOTAL	111	54	48.6	20	18.0	65	58.6	9	8.1

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES* BY MANUFACTURER
PASSING PHASE 1 VEHICLES
1975-1976 MODEL YEAR

MANUFACTURER	TOTAL	TIMING		IDLE RPM		IDLE CO		FAILING ALL	
	N	N	%	N	%	N	%	N	%
GENERAL MOTORS	27	7	25.9	3	11.1	6	22.2	2	7.4
FORD	20	11	55.0	3	15.0	8	40.0	1	5.0
CHRYSLER	5	3	60.0	1	20.0	3	60.0	1	20.0
AMERICAN MOTORS	2	1	50.0	1	50.0	0	0.0	0	0.0
FOREIGN	18	10	55.6	5	27.8	13	72.2	3	16.7
TOTAL	72	32	44.4	13	18.1	30	41.7	7	9.7

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES* BY MANUFACTURER
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
1975-1976 MODEL YEAR

MANUFACTURER	TOTAL	TIMING		IDLE RPM		IDLE CO		FAILING ALL	
	N	N	%	N	%	N	%	N	%
GENERAL MOTORS	56	31	55.4	6	10.7	52	92.9	2	3.6
FORD	16	8	50.0	2	12.5	12	75.0	0	0.0
CHRYSLER	29	21	72.4	3	10.3	29	100.0	0	0.0
AMERICAN MOTORS	9	7	77.8	1	11.1	9	100.0	1	11.1
FOREIGN	14	5	35.7	3	21.4	13	92.9	2	14.3
TOTAL	124	72	58.1	15	12.1	115	92.7	5	4.0

* TOLERANCE FOR IDLE RPM IS ±150 RPM OF MANUFACTURER RECOMMENDED LEVEL.
TOLERANCE FOR TIMING IS ±2 DEGREES OF MANUFACTURER RECOMMENDED LEVEL.
TOLERANCE FOR IDLE CO IS ±0.5 PERCENT.

TABLE 3.113

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES* BY MILEAGE
ALL PHASE I VEHICLES
1975-1976 MODEL YEAR

MILEAGE	TOTAL N	TIMING N	TIMING %	IDLE RPM N	IDLE RPM %	IDLE CO N	IDLE CO %	FAILING ALL N	FAILING ALL %
LESS THAN 5000	12	4	33.3	4	33.3	5	41.7	2	16.7
5000 TO 10000	33	18	54.5	7	21.2	17	51.5	4	12.1
10000 TO 15000	25	15	60.0	4	16.0	18	72.0	1	4.0
15000 TO 20000	23	8	34.8	4	17.4	16	69.6	2	8.7
GREATER THAN 20000	18	9	50.0	1	5.6	9	50.0	0	0.0

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES * BY MILEAGE
PASSING PHASE I VEHICLES
1975-1976 MODEL YEAR

MILEAGE	TOTAL N	TIMING N	TIMING %	IDLE RPM N	IDLE RPM %	IDLE CO N	IDLE CO %	FAILING ALL N	FAILING ALL %
LESS THAN 5000	10	3	30.0	4	40.0	4	40.0	2	20.0
5000 TO 10000	21	11	52.4	3	14.3	7	33.3	2	9.5
10000 TO 15000	15	7	46.7	3	20.0	8	53.3	1	6.7
15000 TO 20000	14	6	42.9	2	14.3	7	50.0	2	14.3
GREATER THAN 20000	12	5	41.7	1	8.3	4	33.3	0	0.0

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES* BY MILEAGE
FAILING PHASE I / FAILING PHASE 2 VEHICLES
1975-1976 MODEL YEAR

MILEAGE	TOTAL N	TIMING N	TIMING %	IDLE RPM N	IDLE RPM %	IDLE CO N	IDLE CO %	FAILING ALL N	FAILING ALL %
LESS THAN 5000	4	1	25.0	1	25.0	3	75.0	0	0.0
5000 TO 10000	27	15	55.6	5	18.5	24	88.9	2	7.4
10000 TO 15000	28	18	64.3	5	17.9	27	96.4	3	10.7
15000 TO 20000	27	12	44.4	3	11.1	26	96.3	0	0.0
GREATER THAN 20000	38	26	68.4	1	2.6	35	92.1	0	0.0

* TOLERANCE FOR IDLE RPM IS ±150 RPM OF MANUFACTURER RECOMMENDED LEVEL.
TOLERANCE FOR TIMING IS ±2 DEGREES OF MANUFACTURER RECOMMENDED LEVEL.
TOLERANCE FOR IDLE CO IS≤0.5 PERCENT.

TABLE 3.114

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES * BY ENGINE DISPLACEMENT
ALL PHASE 1 VEHICLES
1975-1976 MODEL YEAR

CID	TOTAL	TIMING		IDLE RPM		IDLE CO		FAILING ALL	
	N	N	%	N	%	N	%	N	%
LESS THAN 151	28	12	42.9	8	28.6	20	71.4	3	10.7
151 TO 259	17	10	58.8	4	23.5	10	58.8	3	17.6
GREATER THAN 259	66	32	48.5	8	12.1	35	53.0	3	4.5

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES * BY ENGINE DISPLACEMENT
PASSING PHASE 1 VEHICLES
1975-1976 MODEL YEAR

CID	TOTAL	TIMING		IDLE RPM		IDLE CO		FAILING ALL	
	N	N	%	N	%	N	%	N	%
LESS THAN 151	18	10	55.6	5	27.8	11	61.1	3	16.7
151 TO 259	11	5	45.5	2	18.2	4	36.4	1	9.1
GREATER THAN 259	43	17	39.5	6	14.0	15	34.9	3	7.0

PERCENTAGE OF VEHICLES WITH ENGINE PARAMETERS
OUTSIDE OF SPECIFICATION TOLERANCES * BY ENGINE DISPLACEMENT
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
1975-1976 MODEL YEAR

CID	TOTAL	TIMING		IDLE RPM		IDLE CO		FAILING ALL	
	N	N	%	N	%	N	%	N	%
LESS THAN 151	24	10	41.7	6	25.0	22	91.7	3	12.5
151 TO 259	18	12	66.7	3	16.7	17	94.4	2	11.1
GREATER THAN 259	82	50	61.0	6	7.3	76	92.7	0	0.0

* TOLERANCE FOR IDLE RPM IS ±150 RPM OF MANUFACTURER RECOMMENDED LEVEL.
TOLERANCE FOR TIMING IS ±2 DEGREES OF MANUFACTURER RECOMMENDED LEVEL.
TOLERANCE FOR IDLE CO IS ±0.5 PERCENT.

TABLE 3.115

1975 FEDERAL TEST PROCEDURE
ALL PHASE I VEHICLES
TIMING AND IDLE RPM
WITHIN SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	23	1.86	0.91	42.40	24.92	1.74	0.99	13.53	2.19
FORD	8	1.52	0.69	36.39	22.29	1.54	0.51	12.07	2.33
CHRYSLER	3	3.32	1.35	79.88	49.88	1.60	0.08	12.97	3.74
AMERICAN MOTORS	2	1.84	1.56	39.98	43.71	4.17	3.11	14.67	0.48
FOREIGN	12	2.37	1.27	33.06	15.51	1.56	0.71	17.85	7.60
TOTAL	48	2.02	1.08	41.30	26.16	1.75	1.05	14.11	3.71

1975 FEDERAL TEST PROCEDURE
ALL PHASE I VEHICLES
TIMING AND IDLE RPM
OUTSIDE SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	17	2.52	1.47	62.67	38.15	1.39	0.53	14.37	3.16
FORD	17	2.38	2.49	59.21	66.71	1.58	0.52	12.25	2.55
CHRYSLER	12	3.32	1.19	73.38	30.63	1.80	0.45	12.94	1.71
AMERICAN MOTORS	4	1.94	0.61	27.86	10.84	2.78	0.81	17.59	2.74
FOREIGN	13	2.18	0.53	40.83	15.43	1.76	0.93	20.71	3.68
TOTAL	63	2.53	1.63	57.06	43.75	1.69	0.69	14.47	3.79

TOLERANCE FOR IDLE RPM IS + OR - 150 RPM OF MFG. SPECS
TOLERANCE FOR TIMING IS + OR - 2 DEGREES OF MFG. SPECS

TABLE 3.116

1975 FEDERAL TEST PROCEDURE
ALL PHASE I VEHICLES
IDLE CO
WITHIN SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	24	1.76	0.86	40.22	22.20	1.73	0.97	13.41	2.11
FORD	12	1.32	0.45	28.71	11.16	1.59	0.48	13.75	2.75
CHRYSLER	2	1.19	0.55	21.08	7.89	1.58	0.64	12.79	1.90
AMERICAN MOTORS	2	0.88	0.20	10.35	1.81	4.18	3.10	14.68	0.46
FOREIGN	6	2.12	1.44	22.16	9.21	1.61	0.66	16.80	8.75
TOTAL	46	1.63	0.88	32.73	19.25	1.78	1.04	13.89	3.10

1975 FEDERAL TEST PROCEDURE
ALL PHASE I VEHICLES
IDLE CO
OUTSIDE SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	16	2.70	1.45	67.21	38.85	1.38	0.55	14.63	3.30
FORD	13	2.84	2.74	73.32	72.87	1.55	0.55	11.03	1.60
CHRYSLER	13	3.65	0.84	02.92	26.94	1.79	0.39	12.97	2.17
AMERICAN MOTORS	4	2.42	0.35	42.67	18.82	2.78	0.81	17.58	2.76
FOREIGN	19	2.32	0.77	41.82	14.32	1.68	0.88	20.16	4.55
TOTAL	65	2.79	1.56	62.64	42.72	1.67	0.71	14.63	4.21

TOLERANCE FOR IDLE CO IS A MEASUREMENT 9.5%

TABLE 3.117

1975 FEDERAL TEST PROCEDURE
PASSING PHASE I VEHICLES
TIMING AND IDLE RPM
WITHIN SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	19	1.60	0.74	36.45	22.07	1.85	1.06	13.42	2.32
FORD	7	1.34	0.50	30.05	14.27	1.52	0.54	12.44	2.41
CHRYSLER	2	2.63	0.88	51.18	5.74	1.58	0.10	15.32	2.87
AMERICAN MOTORS	1	0.74	0.00	9.08	0.00	6.37	0.00	15.01	0.00
FOREIGN	7	1.93	1.37	26.28	13.32	1.41	0.54	16.21	7.96
TOTAL	36	1.65	0.88	33.28	19.21	1.81	1.15	13.81	3.47

1975 FEDERAL TEST PROCEDURE
PASSING PHASE I VEHICLES
TIMING AND IDLE RPM
OUTSIDE SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	8	1.62	0.68	39.93	20.59	1.66	0.64	14.51	1.36
FORD	13	1.63	0.80	42.19	23.00	1.56	0.47	12.79	2.34
CHRYSLER	3	2.20	1.80	37.55	29.07	1.70	0.50	13.31	1.74
AMERICAN MOTORS	1	1.02	0.00	11.63	0.00	1.98	0.00	14.36	0.00
FOREIGN	11	2.08	0.50	39.95	14.04	1.82	0.97	20.93	3.24
TOTAL	36	1.80	0.80	39.77	19.90	1.69	0.68	15.07	3.72

TOLERANCE FOR IDLE RPM IS + OR - 150 RPM OF MFG SPECS
TOLERANCE FOR TIMING IS + OR - 2 DEGREES OF MFG SPECS

TABLE 3.118

1975 FEDERAL TEST PROCEDURE
PASSING PHASE I VEHICLES
IDLE CO
WITHIN SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	21	1.55	0.67	35.57	18.39	1.80	1.02	13.42	2.10
FORD	12	1.32	0.45	28.71	11.16	1.59	0.48	13.75	2.75
CHRYSLER	2	1.19	0.55	21.08	7.89	1.58	0.64	12.79	1.90
AMERICAN MOTORS	2	0.88	0.20	10.35	1.81	4.18	3.10	14.68	0.46
FOREIGN	5	2.09	1.61	21.64	10.19	1.44	0.55	16.25	9.04
TOTAL	42	1.50	0.78	30.06	16.05	1.80	1.07	13.83	3.08

1975 FEDERAL TEST PROCEDURE
PASSING PHASE I VEHICLES
IDLE CO
OUTSIDE SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	6	1.82	0.84	44.18	30.64	1.79	0.70	14.92	2.18
FORD	8	1.85	0.92	51.79	24.83	1.48	0.52	11.32	1.01
CHRYSLER	3	3.16	1.12	57.62	11.87	1.69	0.21	15.04	2.01
AMERICAN MOTORS	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FOREIGN	13	2.00	0.54	39.63	13.69	1.75	0.93	20.01	4.78
TOTAL	30	2.04	0.83	45.58	20.97	1.68	0.73	15.32	4.38

TOLERANCE FOR IDLE CO IS A MEASUREMENT ≤.5%

TABLE 3.119

1975 FEDERAL TEST PROCEDURE
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
TIMING AND IDLE RPM
WITHIN SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	SD	CARBON MONOXIDE MEAN	SD	NOX MEAN	SD	FUEL ECONOMY MEAN	SD
GENERAL MOTORS	21	3.46	1.77	82.68	35.27	1.30	0.46	13.49	2.14
FORD	7	3.02	1.47	68,69	44.96	1.26	0.65	11.66	1.95
CHRYSLER	5	4.60	1.39	103.40	42.72	1.10	0.44	12.44	2.74
AMERICAN MOTORS	2	2.57	0.53	57.37	19.11	2.35	0.53	15.97	2.57
FOREIGN	8	2.80	0.77	44.77	17.55	1.72	0.83	20.67	3.18
TOTAL	43	3.36	1.55	74.58	37.89	1.40	0.62	14.00	3.33

1975 FEDERAL TEST PROCEDURE
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
TIMING AND IDLE RPM
OUTSIDE SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	SD	CARBON MONOXIDE MEAN	SD	NOX MEAN	SD	FUEL ECONOMY MEAN	SD
GENERAL MOTORS	35	3.95	2.89	87.46	32.61	1.32	0.48	13.39	2.70
FORD	9	3.76	3.02	88.37	89.94	1.89	0.63	11.78	2.88
CHRYSLER	24	3.60	1.60	83.54	28.18	1.68	0.51	13.02	2.14
AMERICAN MOTORS	7	2.52	0.59	46.35	16.39	2,48	0.73	18.08	2.06
FOREIGN	6	3.09	0.87	53.74	20.31	1.23	0.41	21.33	4.62
TOTAL	81	3.64	2.33	80,35	41.50	1.58	0,62	13.76	3.24

TOLERANCE FOR IDLE RPM IS + OR - 150 RPM OF MFG SPECS
TOLERANCE FOR TIMING IS + OR - 2 DEGREES OF MFG SPECS

TABLE 3.120

1975 FEDERAL TEST PROCEDURE
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
IDLE CO
WITHIN SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	4	7.24	7.88	65.18	23.28	1.60	0.77	11.92	3.04
FORD	4	2.29	0.55	23.99	10.68	1.41	0.80	14.86	3.89
CHRYSLER	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMERICAN MOTORS	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FOREIGN	1	2.28	0.00	24.77	0.00	2.51	0.00	20.21	0.00
TOTAL	9	4.49	5.50	42.38	26.72	1.62	0.76	13.76	3.94

1975 FEDERAL TEST PROCEDURE
FAILING PHASE 1 / FAILING PHASE 2 VEHICLES
IDLE CO
OUTSIDE SPECIFICATION TOLERANCES
1975-1976 MODEL YEAR

MANUFACTURER	N	HYDROCARBONS MEAN	HYDROCARBONS SD	CARBON MONOXIDE MEAN	CARBON MONOXIDE SD	NOX MEAN	NOX SD	FUEL ECONOMY MEAN	FUEL ECONOMY SD
GENERAL MOTORS	52	3.50	1.47	87.24	33.70	1.29	0.44	13.56	2.40
FORD	12	3.82	2.70	98.35	74.73	1.69	0.68	10.96	1.63
CHRYSLER	29	3.78	1.59	86.96	31.16	1.58	0.54	12.92	2.22
AMERICAN MOTORS	9	2.53	0.55	48.80	16.45	2.45	0.66	17.56	2.24
FOREIGN	13	2.97	0.80	50.45	17.99	1.43	0.67	21.00	3.84
TOTAL	115	3.47	1.59	81.16	39.82	1.51	0.62	13.85	3.22

TOLERANCE FOR IDLE CO IS A MEASUREMENT ≤.5%

TABLE 3.121

STUDENT'S t VALUES** FOR AVERAGE EMISSIONS OF VEHICLES OUTSIDE TOLERANCES MINUS AVERAGE EMISSIONS OF VEHICLES WITHIN TOLERANCES

	Timing and Idle RPM				Idle CO			
	HC	CO	NOX	FE	HC	CO	NOX	FE
All Phase I								
General Motors	1.63	1.89*	-1.44	0.94	2.33*	2.52*	-1.45	1.31
Ford	—	—	—	—	1.97*	2.18*	-0.19	-2.99*
Foreign	-0.48	1.25	0.61	1.18	—	—	—	—
Total	1.98*	2.36*	-0.34	0.50	4.98*	4.98*	-0.62	1.07
Passing Phase I								
Total	0.76	1.41	-0.54	1.49	2.79*	3.40*	-0.57	1.60
Failing Phases I and II								
General Motors	0.79	0.50	0.15	-0.15	—	—	—	—
Total	0.80	0.78	1.54	-0.39	—	—	—	—

* Significant at the 95 percent level of confidence.

** A dash (—) in the table indicates that the sample size for that particular category of vehicles is insufficient for valid t tests.

TABLE 3.122

CORRELATION COEFFICIENTS FOR PERCENT CHANGE IN EMISSIONS AND FUEL ECONOMY VERSUS CHANGE IN ENGINE PARAMETERS FOLLOWING MAINTENANCE -- ALL PHASE I VEHICLES

	HC			CO			NOX		
	Timing	RPM	Idle CO	Timing	RPM	Idle CO	Timing	RPM	Idle CO
1972-1974									
FTP	0.05	-0.26	0.34	-0.18	-0.19	0.45	0.47	0.32	-0.12
Hot FTP	0.12	-0.22	0.38	-0.31	-0.16	0.47	0.52	0.36	-0.13
Fed. Short Cycle	0.23	-0.13	0.20	-0.12	-0.11	0.37	0.35	0.37	-0.21
Fed. Three Mode (50)	0.24	-0.05	-0.03	-0.00	-0.16	0.08	0.27	0.15	-0.08
Fed. Three Mode (30)	0.08	-0.17	0.01	-0.01	-0.09	0.19	0.25	0.47	0.05
Fed. Three Mode (N)	0.22	-0.22	0.30	-0.02	0.37	0.35	-0.10	0.37	-0.44
Idle (2250)	0.15	-0.05	-0.04	-0.13	-0.06	0.05	0.12	0.01	0.01
Idle (N)	0.20	-0.14	0.16	0.08	0.91	0.40	-0.15	0.39	-0.48
1972-1975									
FTP	0.19	-0.28	0.23	0.17	-0.26	0.27	0.45	0.26	0.20
Hot FTP	0.21	-0.31	0.23	0.13	-0.25	0.20	0.43	0.31	0.25
Fed. Short Cycle	0.25	-0.17	0.30	0.07	-0.12	0.09	0.38	0.32	0.24
Fed. Three Mode (50)	0.27	-0.32	-0.30	0.09	-0.17	-0.24	0.17	-0.11	-0.06
Fed. Three Mode (30)	0.12	0.03	0.12	-0.10	-0.02	0.07	0.24	-0.07	0.05
Fed. Three Mode (N)	0.07	-0.07	0.20	0.14	-0.12	0.13	0.03	0.14	-0.03
Idle (2250)	0.13	0.01	0.22	0.01	0.07	0.10	0.13	0.11	0.00
Idle (N)	0.02	-0.25	0.18	0.06	0.01	0.17	-0.05	0.22	-0.06

	Fuel Economy		
	Timing	RPM	Idle CO
1972-1974	0.36	-0.01	-0.25
1975-1976	0.28	-0.08	-0.16

TABLE 3.123

MULTIPLE CORRELATIONS FOR PERCENT CHANGE IN EMISSIONS VERSUS CHANGE IN ENGINE PARAMETERS DURING MAINTENANCE ALL PHASE I VEHICLES

	1972-1974		1975-1976	
	R	Order of Significant Parameters	R	Order of Significant Parameters
HC				
FTP	0.34	Idle CO	0.38	RPM, Idle CO
Hot FTP	0.38	Idle CO	0.40	RPM, Idle CO
Fed. Short Cycle	0.23	Timing	0.41	Idle CO, RPM, Timing
Fed. Three Mode (50)	0.24	Timing	0.55	RPM, Timing, Idle CO
Fed. Three Mode (30)	—	None	—	None
Fed. Three Mode (N)	0.37	Idle CO, Timing	0.20	Idle CO
Idle (2250)	—	None	0.22	Idle CO
Idle (N)	—	None	0.32	RPM, Idle CO
CO				
FTP	0.45	Idle CO	0.40	Idle CO, RPM
Hot FTP	0.56	Idle CO, RPM	0.34	RPM, Idle CO
Fed. Short Cycle	0.37	Idle CO	—	None
Fed. Three Mode (50)	—	None	0.24	Idle CO
Fed. Three Mode (30)	—	None	—	None
Fed. Three Mode (N)	0.59	RPM, Idle CO	—	None
Idle (2250)	—	None	—	None
Idle (N)	0.39	Idle CO	—	None
NOX				
FTP	0.56	Timing, RPM	0.51	Timing, RPM
Hot FTP	0.62	Timing, RPM	0.52	Timing, RPM
Fed. Short Cycle	0.51	RPM, Timing	0.49	Timing, RPM
Fed. Three Mode (50)	0.27	Timing	—	None
Fed. Three Mode (30)	0.52	RPM, Timing	0.24	Timing
Fed. Three Mode (N)	0.52	Idle CO, RPM	—	None
Idle (2250)	—	None	—	None
Idle (N)	0.56	Idle CO, RPM	0.22	RPM
Fuel Economy	0.44	Timing, Idle CO	0.37	Timing, Idle CO

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